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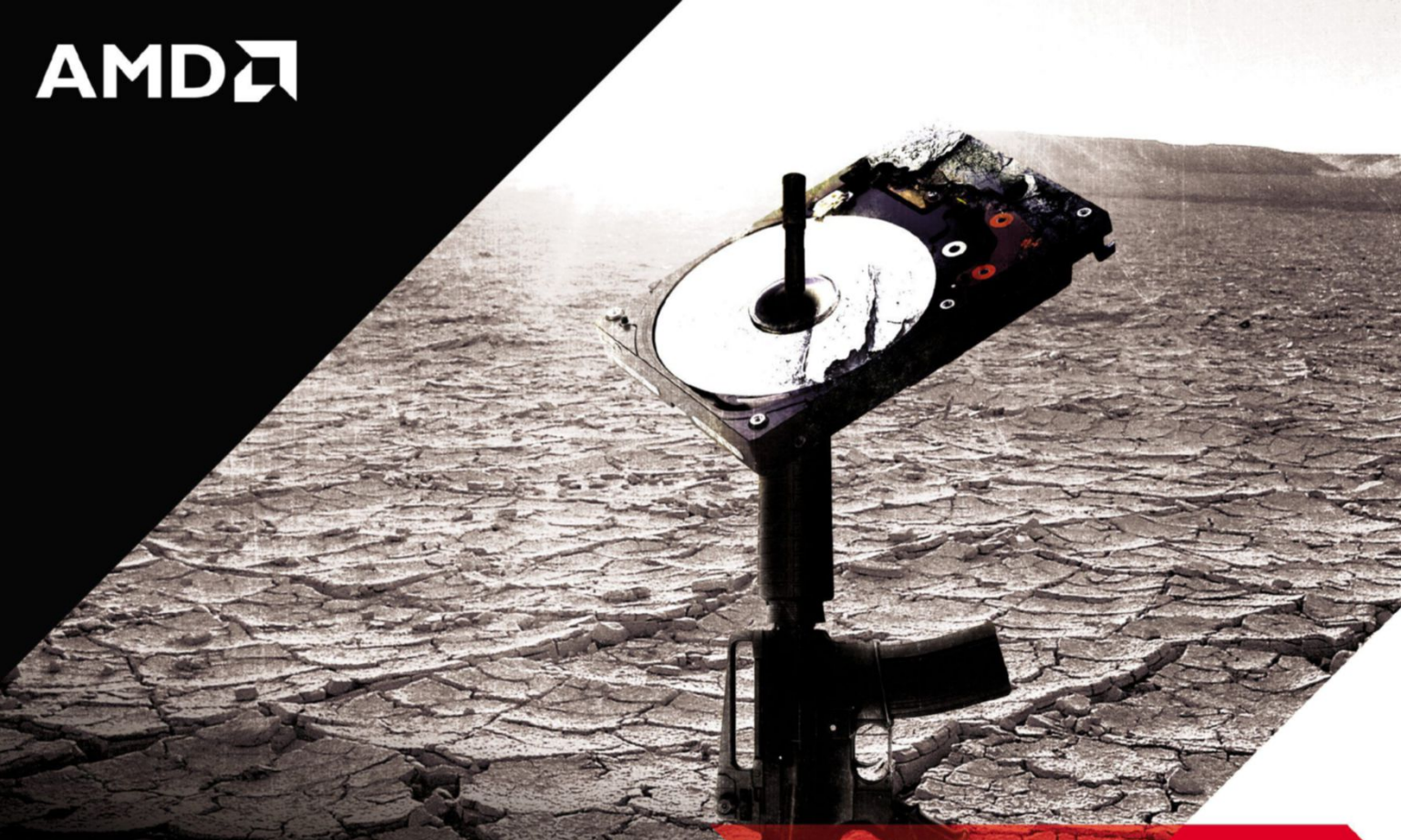

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Cover photo by Mark Madeo

Gordon
Mah Ung

EIGHT IS NOT ENOUGH, BUT IT'LL DO FOR NOW

I LOVE QUAD-CORES. I built my wife's computer using one. I know many people with them and I recommend them to an awful lot of readers because I know not everyone needs to pay the price premium for anything else.

Does that mean I want a quad-core in my next PC build? Heck, no. I want that sweet eight-core Haswell-E processor you can read about on page 44.

"Sure," you say, just as a former co-worker said to me one day when I ran into him at a press conference. "You don't even need a six-core, so why upgrade?" That co-worker, who shall remain anonymous so as to not be publicly shamed, wasn't even talking about Sandy Bridge-E. He was talking about the need to upgrade an old Nehalem with something faster.

Well, good friend, it's simple. I want an eight-core processor because it's faster than a four-core processor. I want to be able to encode Handbrake videos at 300fps and watch the task manager spike all 16-threads for only 15 minutes instead of 24 minutes. I want to be able to render something in Premiere Pro and not have to wait an afternoon for it to finish.

I want the ability to run a pair of video cards as the graphics gods intended them: in full x16 gen 3.0 mode. I want to be able to run five SSDs in SATA 6Gb/s mode on the native (and faster) Intel controller rather than some gimpy valuemart controller the motherboard maker got a deal on. Or even worse—with three of them in SATA 3Gb/s mode.

I want to be able to plug into an M.2 controller running on PCIe 3.0 not PCIe 2.0 so I can get in excess of 1,000MB/s reads instead of 700MB/s reads. I want more speed. I want faster renders. I want more frames per second.

Yes, I know. That's not for everyone. It may not be for you. I don't look down on anyone for buying the right-sized amount of hardware for his or her needs or budget. But at the same time, I don't hate on those who want more. A Core i7-4770K does everything you need and more? Great! It's a flipping fantastic part. Your Pentium G3258 Anniversary Edition floats your boat at 4.7GHz for less than the price of a new keyboard? Wonderful!

But for my needs, for my purposes, I want an eight-core processor with a nice little overclock to 4.5GHz. So, please don't hate on me for what I want. I just want a Maximum PC.

Gordon Mah Ung is Maximum PC*'s editor-in-chief, senior hardware expert, and all-around muckraker.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Intel's Core M takes on ARM tablets

The 14nm tech to enable 9mm-thick fanless PCs

INTEL HAS DISHED UP details of its first 14nm CPU. The new Core M is a mobile chip designed to cash in on dramatic power savings Intel claims for its new 14nm production process and finally, truly, this-time-we-really-mean-it, take the fight to ARM chips for supremacy in ultramobile devices like tablets.

Intel may be the world's largest chip company with a fabrication prowess that's envied by all. It's certainly firmly in control of the PC landscape. But there's another term you could easily apply to Intel these days: surrounded.

With dozens of ARM-based manufacturers including such giants as Samsung, Qualcomm, and Apple hawking billions of devices, Intel is feeling the heat. Even AMD is now making ARM-based server processors, while Nvidia recently put its Tegra K1 into an Acer Chromebook.

It's in this increasingly hostile environment that Intel is hoping to fire its most potent mobile chip yet: the new Core M.

Based on its long-awaited (and slightly delayed) Broadwell microarchitecture, Intel's Core M will be the firm's first chip based on a new 14nm process that promises significant power reductions while also giving what Intel says users expect—desktop-class Intel Core performance.

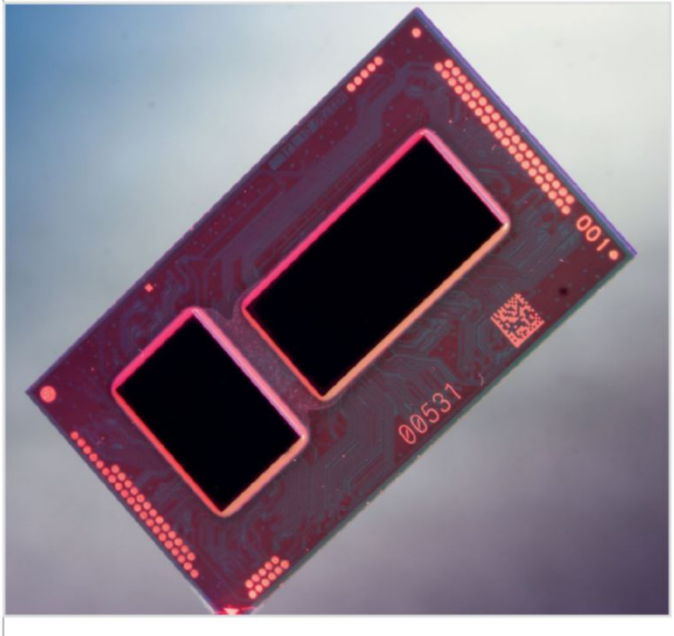
The company didn't disclose exact specs for the chip. But it's expected to beat the best power-sipping Core processor Intel currently offers, codenamed Haswell Y, by a factor of two. Natively 11.5-watt chips, those Haswell Y CPUs also have a "scenario design power" setting of 4.5 watts. That allows OEMs to tune a notebook to run fast at 11.5 watts or to limit its capability and lower its thermals and power consumption to 4.5 watts.

By also reducing the size of the board that the CPU and chipset sit on by 25 percent, and reducing its thickness, Intel says Core M-based tablets could be as thin as 9mm and run without a fan. In fact, Intel has even been demonstrating a reference tablet design just 7.2mm thick.

Intel reckons its 14nm process is a "true" 14nm process, with impressive scaling in gate, interconnect, and fin pitches, too. Intel says while others are still talking about implementing FinFET technology—a more generic term to describe the three-dimensional fin-shaped transistors Intel has been using since Ivy Bridge—Intel is well on the way to a full ramp of 14nm CPUs with second-generation FinFETs. The company admits its 14nm rollout has been problematical. But yields of Broadwell are now said to be "healthy" from three different fabs. Intel doesn't expect it will match the yields of 22nm process until early next year.

Under the hood, Broadwell remains a "Tick" in Intel's chip-development parlance and so not an all-new architecture; Intel expects a 5 percent bump in instructions per clock compared to Haswell. Graphics will get a bigger boost thanks to more execution units—up from 20 EUs to 24 for mainstream "GT2" variants of Intel's integrated graphics. Expect a whole family of chips for everything from micro-servers to desktops to follow next year.

Even with its power reductions, Core M parts aren't expected to take the fight to ARM in handsets, where profit margins are slimmer and power consumption even lower. That'll be left to the Atom. Instead, Core M will initially be strapped into premium 10-inch tablets and convertibles, à la Microsoft's Surface 3, where ARM is vulnerable in performance terms. **–GU**



Intel's 14nm Core M, codenamed Broadwell Y, will be twice as power efficient as Intel's best 22nm Core CPUs.

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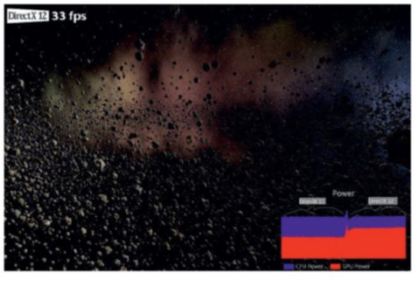
INTEL DEMOS PERFORMANCE GAINS OF DIRECTX 12

Upcoming API's graphics boost and power saving capability highlighted



Windows 9 promises a big graphics boost.

INTEL TURNED HEADS at the SIGGRAPH 2014 computer graphics hoedown in Vancouver with a demonstration of the upcoming Microsoft DirectX 12 API in action. It showed DX12 lifting graphics performance by up to 70 percent over DirectX 11, as used in the Windows 8 operating system.

Intel's demo runs on a Microsoft Surface Pro 3 tablet with an Intel Core i5 processor, and delivered that huge performance leap simply by switching from the old API to DX12, without any hardware tweaks.

Specifically, a 3D app tasks the CPU and integrated graphics with rendering a scene filled with 50,000 asteroids. Two modes—maximum performance and maximum power saving—switch the focus from pure frame rates to maximum battery life. In performance mode, the app runs as fast as possible within the thermal and power constraints of the platform. Using DX11, it pushes 19 frames per second. Switching to DX12 sees a 70 percent jump to 33fps.

"DX12 is designed for low overhead, multi-threaded rendering," reveals Intel. "We've reduced the CPU power requirement and thus freed up that power for the GPU." The upsides are achieved through reducing the draw calls to the CPU plus improved multi-threading. Sound familiar? These kinds of API-driven optimizations are also offered by AMD's Mantle platform, For now, that only works with AMD GPUs. Very likely, we have Mantle to thank for pushing Microsoft towards these improvements.

Whatever, it seems PC gamers can expect a big performance boost with their existing hardware when DX12 arrives with Microsoft's Windows 9 OS, most likely in the first half of 2015. Nice. **–PL**

REVERSIBLE USB ARRIVES AT LAST

USB Type-C is the connector you've been waiting for

THE FULLY REVERSIBLE USB TYPE-C physical connector has been finalized by the USB 3.0 Promoter Group. Just like Apple's Lightning connector, this new USB socket doesn't care which way you plug in the cable. A seemingly simple design change, perhaps, but also a much needed convenience, especially when fumbling around with cables in dimly lit areas or when reaching around to the rear of devices.

You won't be able to plug a USB Type-C connector directly into an existing USB port, though you can still use existing products with the new cable by way of an adapter. In that sense, USB Type-C, which will be part of the USB 3.1 standard, is backwards compatible. Speaking of USB 3.1, the new cable and connector will support theoretical maximum transfers of up to 10Gb/s while delivering up to 100W of power. Yippee. **–PL**

IBM DEVELOPS 'BRAIN-LIKE' SUPER CPU

Neurosynaptic CPU with one million neurons

SCIENTISTS FROM IBM have developed the first neurosynaptic computer chip to achieve an unprecedented scale of one million programmable neurons, 256 million programmable synapses, and 46 billion synaptic operations per second.

IBM's SyNAPSE packs 5.4 billion transistors, making it one of the largest CMOS chips ever built. But it consumes a scant 70mW, which is orders of magnitude less than a modern processor, the company says. "We foresee new generations of information technology systems—that complement today's von Neumann machines—powered by an evolving ecosystem of systems, software, and services," says Dr Dharmendra S. Modha, chief scientist of IBM Research's Brain-Inspired Computing team. In other words, prepare to welcome your new CPU-brain overlords. **–PL**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

NVIDIA'S 64-BIT CHIP
The Green Team is claiming a 64-bit first for Android devices with the dual-core "Denver" version of its new K1 CPU.

SONY PLAYSTATION NOW!
Sony's game streaming service for the PS4 hits open beta. Bring it on, say PC streamers Valve and Nvidia.

THE SMARTPHONE TURNS 20
The chunky IBM Simon of 1994 was an inauspicious start. Fast forward 20 years and all the world's a sucker for the smartphone.

TRAGEDIES

T-MOBILE USERS STRANGLED
Pity T-Mobile's "Unlimited" 4G subscribers. Turns out there are limits to the service and you'll be throttled if you bust 'em.

VIDEO SPAM
First it was Instagram and Facebook. Now Twitter plans to auto-spam your feed with unsolicited video ads.

NO MORE LUCKY CHARMS
The Windows 8 Charms Bar is rumored to be a goner from next year's Windows 9 OS for desktops. Better late than never.

Tom Halfhill

FAST FORWARD

Double Patterning = Double Trouble

THE RELENTLESS MARCH OF MOORE'S LAW is about to stumble. But don't panic. As Winston Churchill said in different circumstances, it's not the end or even the beginning of the end, it's the end of the beginning.

Most of today's high-volume, high-performance microprocessors are manufactured in 28nm or 32nm technology—except Intel's, which use more advanced 22nm finFET technology. For almost all other chip companies, the next generation or "technology node," would normally be 20nm. For Intel, it's 14nm.

AD

Historically, each process shrink brings smaller transistors that occupy less silicon (and so cost less to fabricate), switch between states more quickly (run at higher clock speeds), and operate at lower voltages (consume less power). This holy trinity of Moore's Law has fueled the computer industry for more than half a century.

Regular readers know that Moore's Law has actually been falling behind its predicted curve for several years. Otherwise, we'd have affordable chips with about 38 billion transistors by now—far more than we actually have. People who think Moore's Law is still on track haven't done the math. But the law survives in spirit. Each new node improves in terms of transistor density, speed, and cost.

"Regular readers know that Moore's Law has actually been falling behind its predicted curve for several years. Otherwise, we'd have chips with 38 billion transistors by now.

At 20nm, however, the future doesn't look quite so bright. At 20nm, traditional lithography becomes inadequate. The optics simply can't resolve a transistor that small. Instead, engineers have devised a clever technique called "double patterning," increasing the optics' effective resolution. It works brilliantly, but it requires additional fabrication steps. This seemingly trivial difference can inflate costs by 50 percent.

Consequently, chips manufactured at 20nm have the smaller transistors we normally expect from a process shrink, but they aren't dramatically cheaper. This alone will deter some chip companies from moving to 20nm. In the near term, at least, only the highest-volume, highest-performance chips can realize enough savings and earn enough profit to make the leap worthwhile.

The 20nm node doesn't reduce power consumption by the usual degree, either. Gate leakage is the main culprit. At these minuscule dimensions, a transistor leaks a current even when its power gate is switched off—imagine a dripping faucet. That's why Intel introduced its unique 22nm finFET process in 2011. Intel's field-effect transistors (FETs) have finned gates that increase their volume without commensurately increasing their base dimensions, so they leak less current without occupying much more silicon area. The rest of the industry is struggling to catch up and won't introduce finFETs until the 14/16nm node—the next generation beyond 20nm.

The independent foundries most chip companies employ to make their products are starting high-volume 20nm production right now. They probably won't introduce their first-generation finFETs until they begin 14/16nm volume production in mid to late 2015. Intel, meanwhile, is already rolling out its second-generation 14nm finFETs.

AMD's highest-volume processors are good candidates for 20nm production, despite the technological shortcomings. AMD must do its best to keep up with Intel, even if the cost savings at the 20nm node aren't ideal. But don't expect huge improvements from those chips. Moving to 14nm finFET technology should reap bigger gains, although Intel will still have an advantage for years to come.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report*.

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Thomas L. McDonald

GAME THEORY

Less is definitely more than Myst

***THE ROOM* IS THE GAME *MYST* WASN'T.** My first "Game Theory" column, written some 20 years ago, took *Myst* out to the woodshed and gave it a thrashing. The game was diabolical. Readers howled at the time, but history seems to have vindicated those unforgiving first impressions. Despising *Myst* and its spawn is now the default position for most gamers.

Just to make sure it wasn't my youth speaking all those years ago, however, I gave *Myst* another shot when it was ported to iOS.

AD

Had I matured and mellowed? Had the *Myst* undergone that weird alchemy that renders base games into golden oldies when passed through a nostalgia filter a generation later, just like we're now supposed to pretend the music of the 1980s didn't suck?

Nope. *Myst* isn't any better on an iPad than it was on my 386. It's still a hollow, tedious, irritating sham with a nonsense story, awful acting and dialogue, and a dead world full of pointless wandering and junk puzzles. So, what's the trigger for revisiting all this revulsion? It was *The Room*, which works so well, that reminded me why *Myst* fails so completely and so comprehensively. And *The Room* does work well, damn well, something which PC gamers can see for themselves since that original iOS game has been rebuilt from scratch with improved visuals and offered on Steam for $5.

> It's a game you won't be able to stop playing. I'm not kidding when I say it may well be the best mechanical puzzler of all time: a virtual Chinese box unbound by spatial limitations.

Both are essentially a string of puzzles knitted together with mood and story. But whereas *Myst* is a flabby, overwrought and ultimately worthless thing, *The Room* is sleek and minimalist and a little bit wonderful. There's no pointless wandering, but rather a single room (hence, the title) with a giant, impossibly elaborate puzzle box sitting on a table. The puzzles are embedded in the box, which turns and unfolds with an elegant Steampunk sensibility that looks even better on PC than it did on iOS.

The narrative is elliptical and thus far more evocative, working some basic Lovecraftian tropes with no more than a few stray notes and scrawled words. Most of this is merely atmosphere, however, and combined with an eerie score and sound effects, adds a steady background hum of nervous unease as you go about exploring the box's many levels, drawers, buttons, doors, and mechanisms.

It's this tight structure, as well as the vastly superior puzzle design, that strips away the dead weight of *Myst* to offer a sleek and effective puzzle experience. Lasting only a couple hours, it concentrates on what you want from a game such as this: a bit of atmosphere, a hint of story, and some challenging puzzles.

There are no characters, no dialogue, and no movement: just a box you can view from different angles and letters from a mysterious figure. But it's a game you just won't be able to stop playing. Each element in the puzzle flows so perfectly to the next that it draws you along. You simply have to finish it. I'm not kidding when I say it may well be the best mechanical puzzler of all time: a virtual Chinese box unbound by spatial limitations.

In the end, that's what's most striking about this minimalist creation. The box is a work of art: a thing of beauty and ingenuity, fascinating to watch and interesting to explore.

Thomas L. McDonald is editor-at-large of *Games Magazine*.

THE LIST

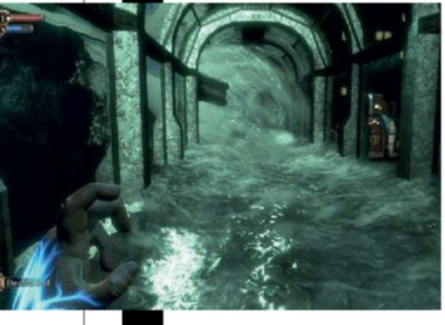
THE BEST VIDEOGAME H2O BY SEAN D. KNIGHT

8 THE ELDER SCROLLS V: SKYRIM

Skyrim's rivers and water effects are so beautiful, we'd swear they make Coors beer out of the beautiful Rocky Mountain water from the game.

4 EMPIRE: TOTAL WAR

This serious tall ship war game was made all the more appealing by beautifully modeled water and deftly reflected ships and debris effects.

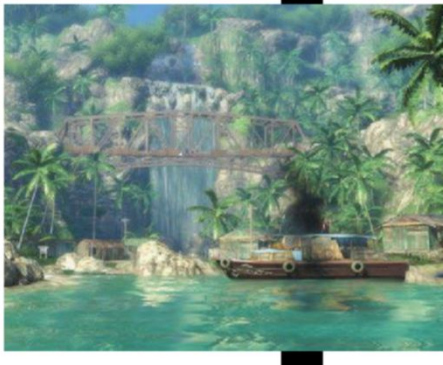


7 BIOSHOCK

Based entirely underwater, it's no surprise that *BioShock* has some of the best water effects around and makes you feel the briny deep every step of the game.

3 FAR CRY 3

It's no coincidence that *Far Cry 3*'s tropical paradise is one of the top time-shares around—just be prepared to be kidnapped and tortured before you enjoy the beautiful water.



6 CRYSIS

If only the Caribbean was as peaceful and heavily armed as the secluded crystal-clear waters of the Ling Shan Islands.

2 HYDROPHOBIA PROPHECY

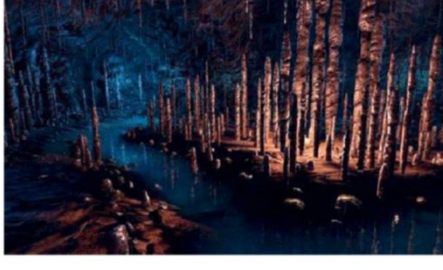
Built on the HydroEngine and with a name like *Hydrophobia*, this game practically flows out of your PC and onto your floor when you play it.

5 TOMB RAIDER

Despite swimming in it, walking in it, and generally being drenched in it, Lara keeps her look together and takes being wet in a game to the next level.

1 DEAR ESTHER

This may "just" be a Source engine mod, but *Dear Esther*'s water effects are so beautiful, you'll be whistling the vintage Old Spice theme in minutes.



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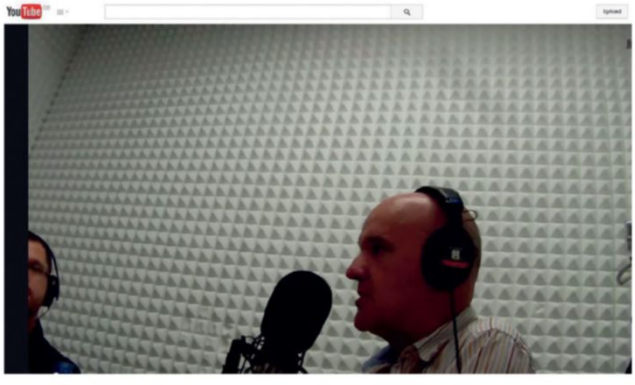
TALKING

AMD VS. NVIDIA: Graphics Grudge Match

The age-old rivalry between AMD and Nvidia reignites in the *Maximum PC* podcast

Earlier this year, AMD's exotically titled "Gaming Scientist" Richard Huddy joined the *Maximum PC* podcast. Huddy is always good for a quote, but we still didn't expect his explosive accusations about Nvidia's GameWorks program, including allegations of intentionally crippling game performance on AMD hardware. Huddy's comments were so hot we had to give Nvidia a chance to respond. Nvidia's technical marketing director Tom Petersen and senior director of engineering Rev Lebaradian stepped up to do just that.

AMD's Richard Huddy drops word bombs on Nvidia in our podcast.



Head to www.maximumpc.com for the full, unabridged podcasts.

AMD

Maximum PC:
An AMD representative recently said Nvidia's GameWorks, "represents a clear and present threat to gamers by deliberately crippling performance on AMD products." Nvidia flatly denies it. Does AMD stand by this claim?

Richard Huddy:
Nvidia's Gameworks is supplied as DLLs—a piece of code which has already been compiled and you can't change. That's how it's given to games developers. The DLLs are black boxes, they're pieces of code written by Nvidia which deliver certain visual effects. You can see that those effects are beneficial to the game in that they raise the visual quality of individual frames. But there's a question about how fast it all runs.

We expect our graphics cards to be judged on the basis of games, rather than synthetic tests like 3DMark.

What these DLLs do is give Nvidia the opportunity to write code which goes into a game and is used to benchmark our hardware. If Nvidia are the good guys, then maybe it's alright for them to write code which benchmarks my hardware. But it doesn't feel quite right.

MPC:
But that doesn't mean Nvidia is intentionally or deliberately introducing code or DLLs that run poorly on AMD graphics cards...

RH:
There is evidence that something malicious is going on here. For example, TressFX (AMD's proprietary hair simulation effect) runs about the same speed on AMD hardware as it does on Nvidia hardware. We supply TressFX in source code and Nvidia has done a good job getting it down to the same execution time as us when running something like *Lara Croft: Tomb Raider*.

However, what you see with *Call of Duty: Ghosts* is something

There's evidence of "malicious" practice by Nvidia, claims Huddy.

rather different. If you turn on Nvidia's GameWorks, you find there's a piece of code that runs seven times slower on AMD hardware than on Nvidia hardware. And it's hair simulation, it's the fur on the dog.

It runs a bit slower on Nvidia hardware, too, but they're willing to throw away some performance so that AMD runs significantly slower. It's something like a 40 percent burden for us and a five percent burden for Nvidia. This code is written by Nvidia and there are contracts in place stopping games developers from changing it. This is not equitable.

NVIDIA

MPC:
Can you respond to AMD's allegations that GameWorks precludes developers from accessing source code and in turn accepting AMD suggestions that would improve performance?

Rev Lebaradian:
There are lots of allegations around the whole source code issue. It's been said we don't provide source code to developers for our GameWorks library. That's just false. We have source code licensing. With close partners we've always shared source code and they can do whatever they want with it, including optimize it for any platform they like.

MPC:
If developers can do anything they want with it, does that include sharing it with AMD?

RV:
AMD doesn't have access to our source code and neither do we have access to theirs. So, there's nothing weird about that.

MPC:
And what about the allegation that Nvidia is deliberately introducing code that performs poorly on AMD hardare?

RV:
I would love to see any proof of that. We've never purposely done anything to harm a game for any other platform. We work with game developers to make sure our customers get an optimal experience with our hardware. But developers are free to work with anybody else, to optimize for any other platform.

MPC:
Then there's the assertion that when a developer signs on to use GameWorks, the contract prevents the developer from optimizing for AMD.

GameWorks Quirks

The war of words between AMD and Nvidia is heating up. But what exactly is Nvidia's divisive GameWorks development program?

GameWorks is middleware, a ready-made library of effects that developers can add to a game to improve visuals and gameplay. GamesWorks includes both graphics (VisualFX) and physics (PhysX). It's fully compatible with DirectX and runs on both Nvidia and, in part, AMD graphics cards. AMD claims GameWorks involves pre-baked software (DLLs) that can't be optimized for AMD hardware. Nvidia says its development partners have access to the source code and can optimize for any platform.

Show us the proof, say Petersen and Lebaradian of Nvidia.

Tom Petersen:
That's just silly. There's nothing in the contract with Nvidia that prevents a developer from optimizing for anybody. Nobody would agree to that kind of stuff.

RV:
No sane game developer would accept those kinds of terms.

MPC:
Richard Huddy has challenged Nvidia to put contracts with game developers into the public domain to settle the argument and says AMD will do the same. What do you make of that?

RV:
That's a silly thing to say. When two companies get into a private contract with each other, if one of the parties were to make it public, you're undermining the trust with your partner. No game developer would appreciate us doing that. And I imagine it's the same for AMD, which is why nothing has been shown so far.

The truth is, if you go and look at the performance numbers from the games that we've worked on, try to find a smoking gun showing that we've really harmed any game on other platforms. It's not there.

Nvidia insists developers are free to optimize for any platform.

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DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Imaging Rigs
> Replacing TrueCrypt
> Installing an SSD

Photo Rig Conundrum

I understand most of your computer builds are predominantly for gaming enthusiasts, but I am contemplating a build that is primarily for Adobe Photoshop and Lightroom 5 use, but with occasional gaming capability. I am also looking for a machine that hums on the net and for media streaming. I am looking for a build for less than around $2,000. Would one of your current blueprints serve this purpose, or maybe an existing high-end build but with a lesser graphics card? Or maybe an existing mid range build but with more RAM etc. Would you be able to provide any advice in this regard? Any existing Internet articles for imaging type rigs always seem to be way out of date.

—Gary Legg

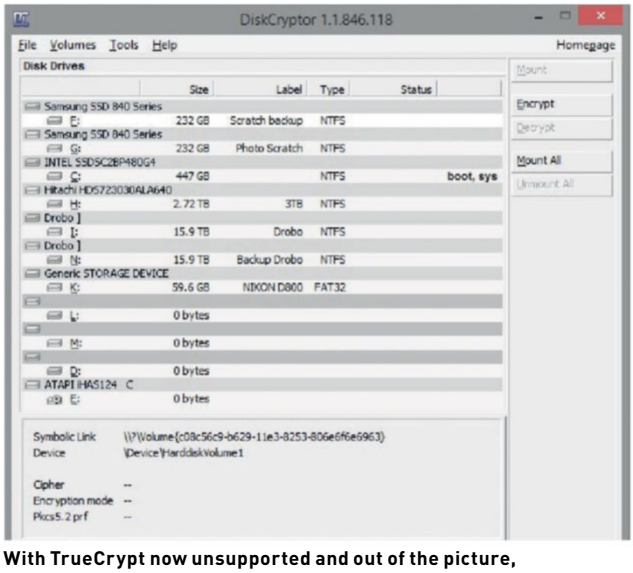
THE DOCTOR RESPONDS: For a Photoshop and Lightroom 5 box, you should be fine with a current-generation Haswell CPU quad core. A quad-core Core i5 will work but there will be times when Photoshop and Lightroom 5 will see a boost from the Hyper-Threading in a Core i7 CPU. Photoshop does need a moderate GPU to enhance performance. Since you intend to also play games, you should probably get a decent GPU in the $300 range for your gaming. A card in that range should work just fine with Photoshop CC. Lightroom 5 performance is a little harder to predict as it's not GPU accelerated and does on occasion need lots of cores. To sum up: buy a Core i7 Haswell CPU, a $300 GPU, and maybe 16GB of RAM, or even 32GB if you work with very large files in Photoshop, and then sink most of your money into a large SSD, a large HDD, and an adequate system to back up those files, too. If you're looking at our Blueprints, a Baseline rig should suit you just fine.

TrueCrypt Replacement

What encryption programs would you recommend to replace the now-unsupported TrueCrypt? I don't need any fancy automated backup or anything, just something easy to lock down my storage drives when I'm not using them.

—Dan

THE DOCTOR RESPONDS: We've also been looking for a replacement for TrueCrypt, as it was our go-to free app for password protecting our important files. For those who aren't aware, the makers of TrueCrypt ended support in May 2014 when Microsoft put a bullet in the dome of Windows XP. The TrueCrypt team recommended everyone just move to the integrated encryption tools built into Windows Vista, and Windows 7/8. However, we did find an alternative named DiskCryptor. It's free, and each release is signed with the author's PGP key, so it's quite safe. The only catch is it only encrypts entire partitions instead of individual folders like with TrueCrypt. Still, it could be useful for an external drive, a USB key, or even your boot drive if you're a bit paranoid.



With TrueCrypt now unsupported and out of the picture, we've moved to DiskCryptor as a replacement.

Teaching an Old PC New Tricks

I have two older PCs I'm considering converting to a Windows Home Server 2011 system. One of these will be set up to work with a Sans Digital 8 bay (8TB) eSATA box, and whatever PC I use will get multiple GB Ethernet cards. The first PC is a P4 Northwood, running at 2.4GHz, with 4GB of RAM running XP SP3 32-bit Home Edition. It has 500GB of PATA HDs on board, an EVGA GeForce 6800, and is currently used to run some older printers that don't have Win7 drivers. It doesn't connect to the net, and everything runs like new including the printers.

↘ submit your questions to: doctor@maximumpc.com

The second is a Core 2 Quad Q9550 Yorkfield 2.85GHz, with 8GB of dual-channel RAM, running Win7 Home Premium 64-bit, a 1GB Gigabyte I-Ram drive (for Temp, Tmp, and IE files), 500GB of SATA II HDDs, and a Gigabyte GeForce GTX 550 1GB video card. It is currently used as a secondary gaming rig for guests. This PC does have net access and everything also runs like new. Do you think the P4 will work well as the WHS 2011 server (with all the extras, such as media streaming), or will it just not have the horsepower? (I'm thinking of how many newer NAS boxes only have Atom or ARM processors and low RAM.) I was also thinking of a dual boot setup to run the old printers.

—George

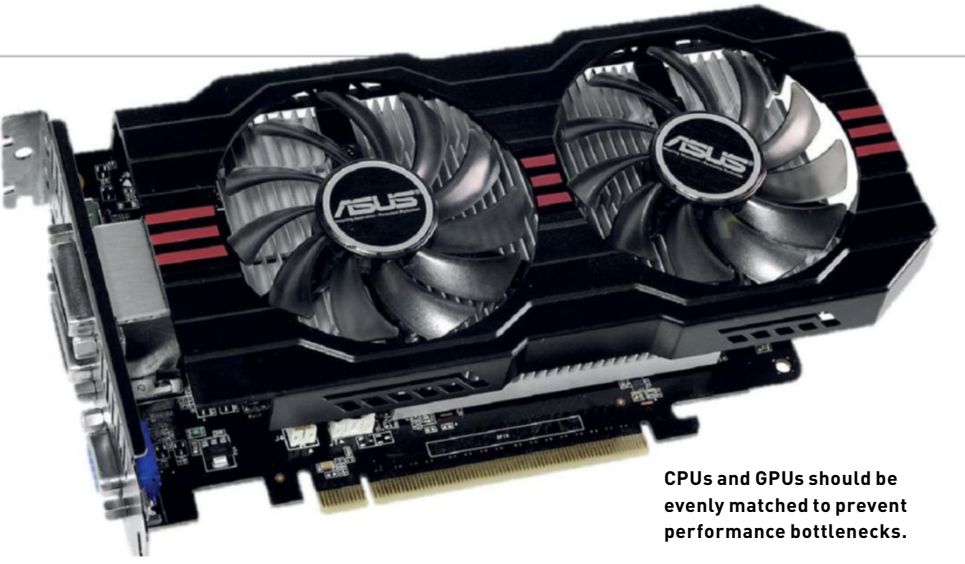
THE DOCTOR RESPONDS: First, you're out of luck with the Northwood Pentium 4 machine. Windows Home Server 11 is a 64-bit only OS and requires a CPU with x86-64 support. The Northwood P4 (the original Socket 478 CPU) was 32-bit only. Only later versions of the P4 and Pentium D had 64-bit support once Intel realized AMD was going to win that battle. The Core 2 Quad Q9550 is 64-bit so you'd have to use that machine. That may be overkill for a home server as there are lots of ARM-based and Atom-based NAS units out there. In the doc's experience though, those machines have atrocious performance and even the most basic Celeron NAS units are faster.

SSD and HDD Decisions

When installing an SSD, besides the OS, what other programs should be installed on it? I had an SSD on my PC, but it died, and I had a computer tech move everything over to my regular drive. The original SSD was only 60GB, but I am planning on buying a larger one. Should I move all of my programs over or just my web browsers?

—William R Miller II

THE DOCTOR RESPONDS: This is a common situation William. You have your smallish SSD sitting there, and a "regular drive" to use your words, so how do you split up your data and programs? The answer is actually quite simple, and is dictated mostly by the capacity of the drives in question. Since most of us are rocking SSDs ranging in size from 128GB to 512GB, we simply can't put all of our data on the SSD like back in the day when we had one hard drive that held everything, including our OS, data, and all our programs. Therefore, the division is quite simple. You put your OS and installed programs (including games) on the SSD, and all your "data" on the hard drive. You can then change all the shortcuts in Windows to be on the hard drive by right-clicking those shortcuts and fiddling with their properties. Be sure to check out http://goo.gl/dW6yC9 for our more in-depth explanation of how to do this.



CPUs and GPUs should be evenly matched to prevent performance bottlenecks.

CPU or GPU Bottlenecking

I have pre-ordered one of the Pentium Anniversary Editions, and already have an Asus GeForce GTX 750 Ti 2GB OC. Is this a good match, or will one of these parts be a performance bottleneck? Also, what would be a good mobo for this build? Normally I would just get the most expensive one I can afford, but this system will already have some built-in limitations, so I don't want to go overkill.

—Chris Hall

THE DOCTOR RESPONDS: Chris, if you mean the unlocked Pentium Anniversary Edition, the Doc thinks it's a good match. For those who don't know, the Pentium G3258 Anniversary Edition is an unlocked budget dual-core chip. The staff at *Maximum PC* likes to call it the Pentium K to denote its unlocked status. With a base clock of 3.2GHz, the part does not have Hyper-Threading but should overclock into the 4GHz range easily. You asked if that would create a bottleneck situation and it shouldn't. However, you didn't say what you intend to do with the system. If it is primarily a gaming box, you're in good shape as most games are still optimized for dual cores. If you intend to do a lot of video editing or multi-threaded tasks, that dual-core CPU will certainly be the limiting factor. The good news is you can make up for some of the performance loss by overclocking the chip. As far as motherboard expenditures, you should probably buy primarily on the features you need. The best example is Thunderbolt 2. If you don't intend to use it, don't pay for it. If you never intend to overclock or run multi-GPUs, pick a board without those features to save some cash.

OEM SSD Upgrade

I have an Asus M51AD Essentio Series computer, which came with an HDD, Windows 8.1 installed, and a recovery partition. My problem is I want to replace the HDD with an SSD, but I have no Windows disk to do a fresh install to the SSD. I have created a separate recovery drive from the recovery partition, but queries on the Internet indicate a fresh install to a new drive cannot be done from either the recovery partition or drive. I can't install the SSD along with the HDD because the motherboard Asus used for this unit only has two SATA connections available, one used for the optical and the other for the HDD.

—Hal Smith

THE DOCTOR RESPONDS: This is an advanced maneuver Hal, but it is possible. Manufacturers obviously don't want that recovery partition, which is a bootable OS, copied to any old drive, so they usually lock it down. However, if the hard drive that came with your system dies, then you'd lose your only copy of Windows that you rightfully purchased, so OEMs usually give you the option of making recovery disks in case of hard drive failure. This will copy the hidden partition with the OS on it to an external drive, so you can copy your OS in "factory condition" to a new hard drive in the future. What you need to do is make those disks (we usually use an 8GB USB key for this), which creates a bootable backup of the recovery partition. Once that's complete, pull your HDD and install the SSD. Next boot from the new recovery backup (the USB key, if you used one), and it should give you the option to recover your OS to a drive. Select the SSD and it should install. You should just buy an external USB enclosure for your old hard drive and use it for data storage, but be sure to back up that data either to the cloud or to another external drive.

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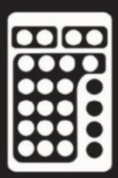

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THE GEARHEAD'S GUIDE TO MINECRAFT

How to build an amazing experience with the right tweaks, mods and hardware

by Tom McNamara

Computer games age in dog years, and *Minecraft* has been around since 2009. So by most measurements, it should be in the old folks' home, laid back in a recliner, watching reruns of *Jeopardy*, and gumming some tapioca. Instead, the game is a true phenomenon. Like *World of Warcraft* or *Counter-Strike*, it's fun, plus frequently evolves to keep things interesting.

With this game, you can take several *actual* months just building your own personal fortress, one digital block at a time. Or you can hop on a multiplayer server and help people build cool stuff until the break of dawn. Each world you create is also randomly generated, so it's never the same place twice. (If you've never tried *Minecraft* and you'd like a basic introduction, check out http://bit.ly/MPC_MCbeginner for our friendly online guide.)

Some of *Minecraft*'s huge runaway success—almost 17 million have bought the game—can be attributed to its relatively low system requirements. It'll run fine on machines that were left behind long ago by other games. But don't take that to mean you'll want to play it on integrated graphics, as you can pile up mods to push even high-end hardware to the limit. We've the secret sauce ingredients to make this game shine in a way you might never have witnessed before. And of course, we'll show you three of the most stunning *Minecraft* PCs you've ever seen.

THE BASE GAME IS JUST A STARTING POINT

MILLIONS OF GAMERS CAN'T BE WRONG

Every empire begins with a single block of grassy dirt.

A screenshot of *Minecraft* should be a familiar sight to every gamer. You probably went through a *MC* phase yourself, and haven't played the game in a few years. Perhaps you feel content with memories and see no need to go back. Well, if you've never modded *Minecraft*, you're wrong. If you've tried one or two texture packs, you're still wrong. You rode a bicycle when you could've been chauffeured in a limousine. That's OK, we all make mistakes.

Like the game itself, you won't see the potential until you start digging. We dug deep and found glittering gems. While the default *Minecraft* is full of blocky objects, ugly textures, and jaggy edges, we can make it look pretty after a half an hour of work. And it won't cost a dime. Like with *Skyrim*, there's a small army of modders adding stuff you didn't think could exist, from sparkling waterfalls to gently swaying grass.

If you have an entry-level PC, you can still boost your performance. When we started *Minecraft* back in the day, it was with a single-core AMD Athlon 64 4000+, 2GB of RAM, and a Radeon X1550 with 256MB of GDDR5 onboard, so we sympathize with low-end struggles. Back then, we tinkered with every setting, like a mechanic tuning an aging minivan. And with enough duct tape and elbow grease, we got it to work. On the next page, we'll explain the settings that can make a difference with modest hardware.

TALKING RIGS WITH YOUTUBE PHENOMENON JORDAN *"CAPTAINSPARKLEZ"* MARON

With almost 8 million subscribers, Jordan Maron, aka CaptainSparklez, is one of the highest-ranked Youtube personalities on Earth and instantly recognizable as a *Minecraft* celebrity. We caught up with the good Cap'n and grilled him on how he got his start and the hardware he runs. –GU

MPC: YOU'RE ARGUABLY THE ORIGINAL *MINECRAFT* YOUTUBE CELEBRITY. CAN YOU TELL US HOW YOU GOT ON THIS PATH?
CAPTAINSPARKLES: I don't know about the original, nor the celebrity part, but I've been doing it for what feels like a while, at least as far as Internet time goes. I was initially shown the game by a friend who was quite bananas about it, so I gave it a try myself, uploaded a few videos, and the reception was pretty super, so I stuck with it.

MPC: SO, WHAT'S A TYPICAL DAY LIKE FOR CAPTAINSPARKLEZ?
CS: Nothing too glamorous. Lots of sitting at my computer finding new things to record, recording them, browsing, and reading articles. Occasionally I'll venture out of my cave into the scary place known as outside for a meeting or some skateboarding.

MPC: NOW, ONTO THE HARDWARE...
CS: I've got a 3.5GHz Core i7-3970X running at stock speed, GeForce GTX Titan, 32GB RAM, 500GB SSD, and a 2TB hard drive. I've got it hooked up to three 1920x1080 monitors—two 23s and a 24-inch.

MPC: WHY DID YOU PICK THOSE PARTS?
CS: Given the gaming, editing, 3D animation, and rendering I do, it's in my interest to have the fastest machine possible, so I just opted for what I felt to be top-of-the-line at the time. It's probably not the most cost-effective build, but it's served me very well.

MPC: DO YOU RUN ANY SPECIAL MODS?
CS: No "special" mods, but when I pile on 100 of them, it helps to have good hardware. Even then there can still be a fair amount of lag at points. I suppose some of the shader mods get a performance boost from the Titan; I had some trouble running them on my old machine, but they are pretty flawless now. Those shader mods are super cool, by the way; looks like nothing you'd have thought possible in *Minecraft*.

MPC: DO YOU BUILD OR BUY YOUR PCS?
CS: This is the bit where I fess up. I don't assemble my own PCs. I've heard too many complaints from friends who built computers only to find they wired something wrong, troubleshoot, then find out a part arrived broken, figure out which one, replace, and repeat the process. It isn't something I find fun, so I pay the premium to pick up a finished rig a week after ordering.

MPC: WHAT HARDWARE CONFIGURATION DO YOU RECOMMEND FOR *MINECRAFT*?
CS: Folks may consider it overkill, but if you're playing *Minecraft*, you're probably playing other games as well, so as a general PC building recommendation I suggest the Core i7-4790K. It should do everything you'd hope for a long while to come. I'd also recommend something like a GeForce GTX 760, at least 8GB RAM, and possibly a 256GB SSD if you're feeling fancy. The whole setup shouldn't cost too much more than $1,000.

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PERFORMANCE TIPS

DON'T GET SHAFTED WITH SUBSTANDARD MINECRAFT *PERFORMANCE*

When you start the game and click on the "Options" menu, you'll see one visual setting: FOV (Field of View). That's basically the cone of vision in front of you. The "Normal" setting is 70 degrees wide, but the slider goes from 30 to 110. If first-person games make you feel nauseated, you may find some relief by increasing the FOV to 80, 90, or even higher. This will create a sort of fish-eye camera effect at the highest level, but it's preferable to losing your lunch. Click on the "Video settings" to get to the meat of the performance settings.

Graphics has two settings: "Fast" and "Fancy." The latter enables transparency, shadows, enhanced water effects, and better-looking clouds. Almost every setting in this menu will take effect without requiring a restart, so you can go back and forth to see the effect that different settings have on your performance. If you press "F3" while playing the game, you'll get a frame rate counter in the upper left-hand corner, among other things. This will put a lot of text on the screen. You can make this smaller by changing the GUI Scale to "Normal" or "Small."

UNLOCKING FRAME RATES

Setting Smooth Lighting to "Maximum" creates smaller gradients of light from one block to another. The actual Brightness setting has no impact on performance and is purely a matter of taste, though it can help you distinguish certain types of blocks in dimly lit areas. The particle setting determines whether or not you see debris or dust when you run around or chop a tree, and liquid spray.

Vsync attempts to lock your frame rate at 60fps, if your monitor has a 60Hz refresh rate. If your PC can't maintain that, your fps gets knocked down to 30. If you can't maintain that, then vsync drops you to 20. And so on. We recommend disabling it and using Adaptive V-Sync for Nvidia GeForce video cards, or Dynamic V-Sync for AMD Radeon video cards. This will automatically disable vsync when your fps falls below 60, and re-enable vsync when your frame rate goes back up.

Anisotropic filtering increases the sharpness of textures that are distant from the player. This one usually doesn't impact performance very much, so you should be able to crank it all the way to 16. Render distance determines how much of the game world you actually see around you. Adding more chunks pushes the horizon back, but it can cause stuttering as the game takes a moment to draw that area. The Max Framerate setting can be ignored if you're running a standard 60Hz monitor. Dynamic/adaptive vsync will override it.

A wide FOV stretches objects on the edge of the screen but can help with motion sickness.

SMOOTHING IT OUT

Advanced OpenGL enables a feature called Occlusion Culling, which basically tells your video card to not render things that the player can't see. Some very old GPUs don't support this.

Disabling clouds can increase your performance and may help with certain visual glitches. The fullscreen toggle has minimal impact on performance if the game window is already maximized. If you leave fullscreen off, this will make it easier to Alt-Tab to other windows. Mipmap levels smooth out surface detail according to distance from the player, but higher levels need to be balanced with anisotropic filtering to prevent excessive blurriness.

Installing the Optifine mod (detailed in the next section) adds a host of additional video settings that would require an additional article to fully cover. Thankfully, the mod provides pretty informative tool tips that pop up when you hover over each setting. Generally, we recommend only changing a few settings at a time, so you know which one has the most impact (or which one is causing glitches). It also automatically enables the use of a second CPU core (vanilla *Minecraft* is only single-threaded), which can improve frame rates right away.

> "We recommend only changing a few settings at a time, so you know which one has the most impact (or which is causing glitches)."

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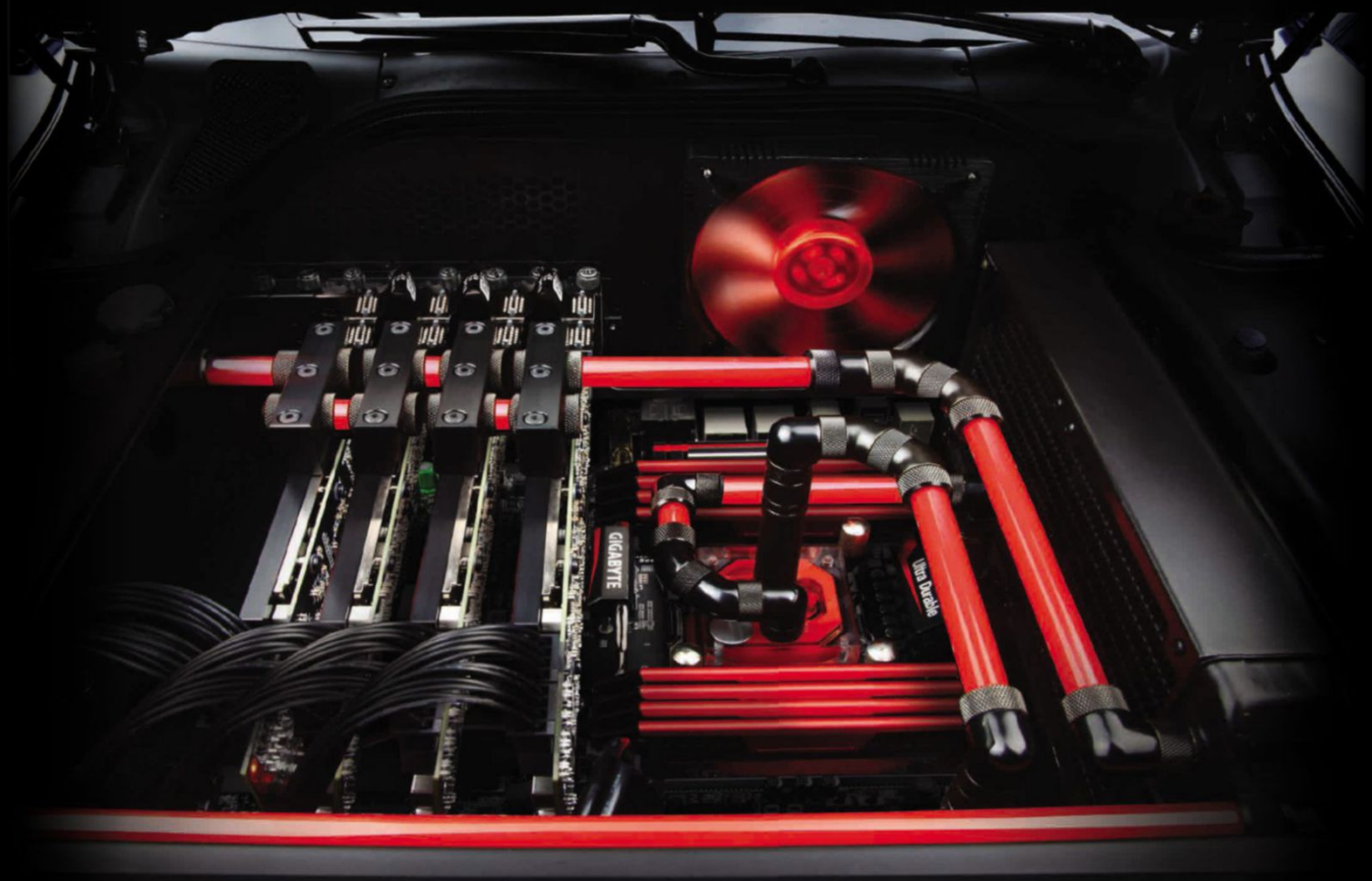

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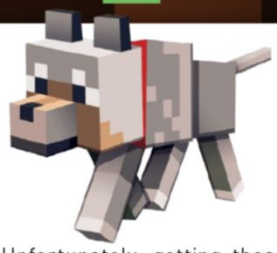

Out of the box, *Minecraft* is a spiffy game. But it clearly ain't the belle of the ball. Its blocky objects and pixelated textures are an acquired taste, like black coffee or limburger cheese. And you've probably noticed its performance can get pretty chunky, too. Thankfully, a veritable cottage industry of mods has grown up around the game. You can smooth out those textures, or make them even more retro. You can add nice lighting effects, too.

Unfortunately, getting these mods to all play nice with each other is still surprisingly tricky, despite the game being in active development for more than five years now. So let's start simple, with the texture packs.

A WHOLE NEW WORLD

There are piles of websites dedicated to downloadable *Minecraft* content, but for texture packs (referred to as "resource packs" by the *Minecraft* community), we stuck mostly to www.planetminecraft.com and www.curse.com (the latter of which has content for a bunch of other games, too). We prefer these two sources because of easy navigation and sorting. Pixel count is one thing to sort for. The textures can range from 8x8 pixels to 512x512. For reference, the vanilla textures are 16x16. Higher pixel counts can add realism, but this requires more hardware horsepower. You have to strike a balance depending on your situation. Try to get the most up-to-date packs, otherwise you can end up with an awkward mix of modded and vanilla textures.

If you have a 64-bit CPU and a 64-bit operating system, we recommend installing the 64-bit version of Java. Go to java.com, click on the "Free Java Download" button, then click on the link labeled "See all Java Downloads" and select "Windows Offline (64-bit)." This version does not check for updates, though, so you have to remember to do that on your own.

FEELING RESOURCEFUL

Some of these packs may instruct you to use MCPatcher HD, a Java program that helps these packs integrate into the game. Just Google the name of the program to find a link to www.minecraftforum.net (the official forum) that provides legit download links. Basically, once you've Java installed, double-click on the MCPatcher file to run it like any other program, and click the "Patch" button on the bottom.

When you've downloaded a resource pack, fire up *Minecraft*, click on the "Options" button, select "Resource Packs," and click the button that says "Open resource pack folder," where you can drop in all your packs. Use this opportunity to create a folder shortcut on your desktop. Then click "Done" and the "Resource Packs" button again, and your packs should show up. Click on the one you want to use to activate it, and click the "Done" button again. The more complex the pack, the longer it will take *Minecraft* to load it up. Windows may even tell you the program is no longer responding. If that's still the case after a minute, you may need to force-close the program and try a less complex pack.

> "Higher pixel counts can add realism, but require more hardware horsepower, so strike a balance."

Vanilla *Minecraft* textures date back to the mid 1990s...

... but resource packs such as KoP Photo Realism change everything.

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Here's some interesting terrain in the vanilla version...

... now add the Traditional Beauty resource pack and SEUS Shaders.

FIFTY SHADERS OF GREY

There are some things that no resource pack can address. What if you want to see tree branches and grass sway in the wind? What if you're not happy with the way the game's lighting works? That's where shader mods come in. Adding these to the game is a three-step process. First, we install a mod loader, then we install the shader framework, and finally, we install the actual shader pack.

The Minecraft Forge API (Application Programming Interface) is our mod loader. Visit www.minecraftforge.net to grab that. As with the resource packs, get the one that matches your game version. There may be "latest" and "recommended" variants. The latter usually has wider compatibility with the available mods. Before installing Forge, run the game once to set its environment correctly, then shut it down. To install Forge, just double-click on the "EXE" file to install it like any other program.

SEEKING SEUS

Next, you need the GLSL Shaders Mod to enable shader packs. This one doesn't have its own website and instead resides on the *Minecraft* forums. If you do a Google search on the mod's name, the forum link should be your top search result. Download the mod from there, double-click on that "resourcepack" desktop shortcut you created earlier, go one folder up to the one labeled ".minecraft," and open the "mods" folder. Drop the Shaders Mod in here. Go back to ".minecraft" and open the "shaderpacks" folder next.

We used Sonic Ether's Unbelievable Shaders (SEUS) for this article. It's available at sonicether.com. If you have a high-end PC, choose an "Ultra" version. Midrange PCs will be better off with "Standard," and entry-level rigs should stick to "Lite." Download your chosen version and drop it in your "shaderpacks" folder. Then start *Minecraft*, select the "Forge" profile from the drop-down menu in the lower left-hand corner, click "Play," then select "Options," choose "Shaders," and click on the name of the shader to activate it.

FORGING AHEAD

Lastly, you can grab the Optifine mod, available at optifine.net, to boost performance and further beef up your visuals. You can use this one with or without Forge. Next choose the right version for you. The "Ultra" version has the most enhancements, "Standard" is the most compatible, and "Light" is good for laptops and budget PCs but won't work with mod loaders such as Forge. Without Forge installed, just download the ".jar" file and double-click to load the installer. With Forge installed, drop the ".jar" file in the "mods" folder mentioned earlier. If you get stuck somewhere, this mod has its own thread on the official forums with detailed advice for troubleshooting.

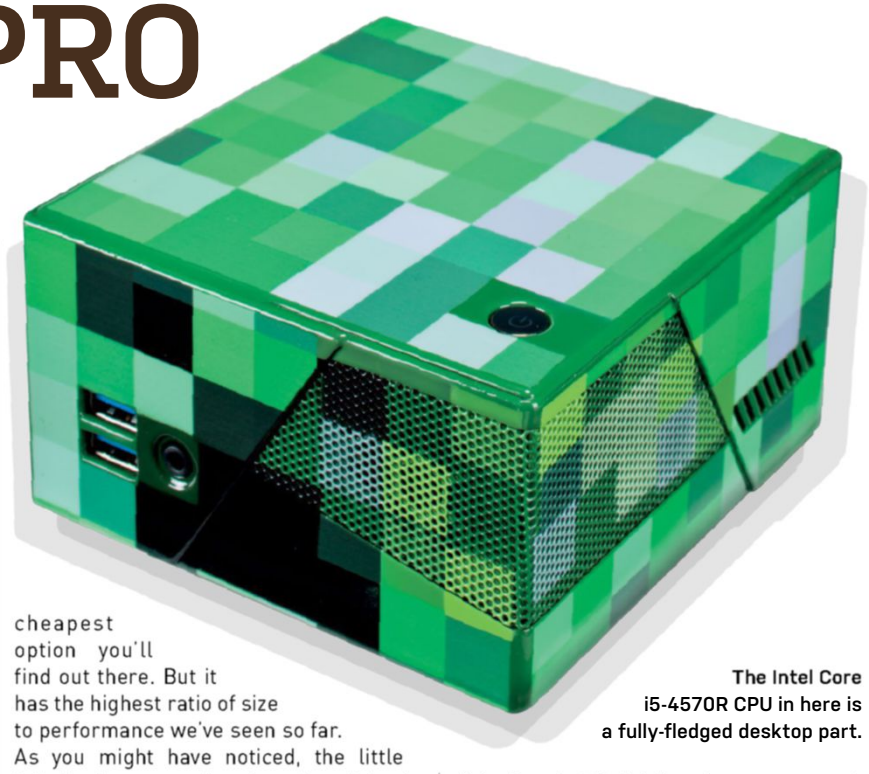
> "If you want to see grass sway in the wind or you're not happy with the lighting, shaders are for you."

MINECRAFT AT 4K? YES AND NO...

Since *Minecraft* doesn't demand much of your hardware, we hooked up an Ultra HD monitor to see what kind of frame rate we would get with the resolution cranked to 3840x2160. At four times the res of a 1080p monitor, things can start to get chunky. But even the integrated graphics of a quad-core Intel Core i5-4570R could maintain around 60fps, as long as we didn't install any shaders. A system with an Intel Core i7-4770K and a GeForce GTX 780 Ti, meanwhile, flew along at 250–300fps in vanilla mode. When we activated a shader, though, it dropped down to about 35fps. It could be that the shader itself needs some optimization, or that the shaders just put a lot of strain on the GPU. Back down at 1080p, the 780 Ti system maintained about 60fps with all shader effects enabled. Check out the next few pages to get the nitty-gritty on the three systems we built to play *Minecraft*.

THE GIGABYTE BRIX PRO

THIS LIL' GUY WILL CREEP UP ON YOU



The Intel Core i5-4570R CPU in here is a fully-fledged desktop part.

Since *Minecraft* doesn't use more than two CPU cores (and even then, not without a mod), and a video card is more of a recommendation than a necessity, we can get up and running with a very compact and portable unit. Enter the Brix Pro series. We reviewed the Intel Core i7-4770R version in the March issue and gave it our Kick Ass award. This one is nearly identical; the CPU here is the i5-4570R, which doesn't have Hyper-Threading. We still get Intel's Iris Pro 5200 graphics integrated into the CPU, and the 128MB L4 cache, plus an mSATA slot, 2.5-inch drive bay, and a pre-installed 802.11ac Wi-Fi card with Bluetooth 4.0. And with four USB 3.0 ports, an HDMI port, Ethernet port, and mini-DisplayPort, we're not lacking for external connections.

MINECRAFT CUBED

With a street price of $470, plus buying your own Windows license, RAM sticks, and an internal storage device, the GB-BXi5-4570R is certainly not the cheapest option you'll find out there. But it has the highest ratio of size to performance we've seen so far. As you might have noticed, the little fella is also very cube-shaped, so it lends itself nicely to a themed custom paint job. Another bonus is that it takes very little time to set up. Just remove four screws on the bottom cover, snap in your RAM, remove the SSD tray, install the SSD in the tray, put the tray back, and close her up. You're done.

Unfortunately, the integrated graphics didn't play nicely with our shaders, causing the game to crash whenever one was loaded, but we had no trouble with resource packs or the Optifine mod. Considering the performance hit that shaders caused with our beefier systems, the game probably would have chugged anyway. There's also a little fan inside the Brix Pro, but it didn't spin up very much during our sessions, and the unit never got hot. However, if you stress all four cores with video encoding or other highly multi-threaded activities, you'll hear it from a few feet away. All in all, we were pretty happy with the results we got.

You can build a solid entry-level gaming PC for this kind of money, so the Brix Pro is not the best option for raw performance or upgradeability. But if you want something super compact and portable, this is your ticket. In fact, if you want this one, you have a chance to win it, as we're giving it away. Visit http://bit.ly/MPC_mcgiveaway for details of our Creeper-themed Brix Pro giveaway.

INGREDIENTS

	Part	Price
Case	Gigabyte GB-BXi5-4570R	$470
PSU	Bundled	N/A
Mobo	Integrated	N/A
CPU	Intel Core i5-4570R (soldered in)	N/A
Cooler	Integrated	N/A
GPU	Intel Iris Pro 5200 (integrated)	N/A
RAM	2x4GB Corsair DDR3/1600 SODIMM	$86
SSD	240GB SanDisk Extreme II	$130
OS	Windows 8.1 64-bit OEM	$100
Total		$786

> "Set up is quick. Just remove four screws, snap in your RAM, install the SSD, and close her up. You're done."

THE DYNAMITE BUILD

IT WILL BLOW YOU AWAY

When we used Cooler Master's Elite 130 case for a "Build It" feature in *Maximum PC*'s February issue, we thought it wasn't possible to make a case any smaller and still cram in a full system. Then the company sent us its Elite 110, which is about half as long.

While it's true that your options are more limited, we discovered it's still possible to make some sparks fly. The breakthrough is thanks in large part to vendors such as Zotac, Asus, and MSI, who've figured out how to miniaturize Nvidia's GeForce GTX 760 video card, which has a very good price-performance ratio at around $250.

GET OUT MY GRILL

Zotac's result is slightly longer than the other two and needs two PCI Express power cables instead of one, but we still end up with a little room to spare, and the case actually takes full-sized power supplies. Our friends at Smooth Creations painted it to look like a TNT block from *Minecraft*. Unfortunately, painting the front grill simply isn't practical, as the case needs that opening to create airflow for all the hard-working gear crammed inside. Because of the way the power supply is situated, you can't put a big cooler on the CPU. But a locked Intel Core i5 CPU is still a very good chip to have running things.

The Gigabyte GA-H97N-WIFI Mini-ITX motherboard will take 16GB, but 8GB was fine for our needs. While our CPU and RAM are basically equal to the Brix Pro, this case can take four 2.5-inch drives and has a mount for a 3.5-inch drive. Add the video card, and you're on a whole new level of performance.

The Elite 110 comes with one 120mm intake fan and can mount two 80mm fans on the side.

At 1080p with a 64x64 texture pack, the Optifine mod, and SEUS shaders, our Intel Core i5-4430 and GTX 760 kept us in the 40–50fps range. Without the shaders, frame rates averaged around 200. At Ultra HD resolutions, we still consistently hit over 60fps, as long as we didn't load a shader. That would knock the fps down to 15–20.

This is roughly the level of performance we expected. It would be nice to hit the 60fps mark at 1080p, but to achieve that it looks like we'd need to go up a notch on the video card, and maybe overclock the CPU.

INGREDIENTS

	Part	Price
Case	Cooler Master Elite 110	$50
PSU	Cooler Master V550 550w	$80
Mobo	Gigabyte GA-H97N-WIFI	$100
CPU	Intel Core i5-4430	$180
Cooler	Integrated	N/A
GPU	Zotac GeForce GTX 760 2GB AMP! Edition	£240
RAM	2x4GB Corsair DDR3/1600	$86
HDD	1TB Seagate Barracuda	$55
SSD	240GB SanDisk Extreme II	$130
OS	Windows 8.1 64-bit OEM	$100
Total		$1021

> "Without the shaders, frame rates averaged around 200. At Ultra HD resolutions, we still hit over 60fps."

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*Based only on consumer-class SSDs

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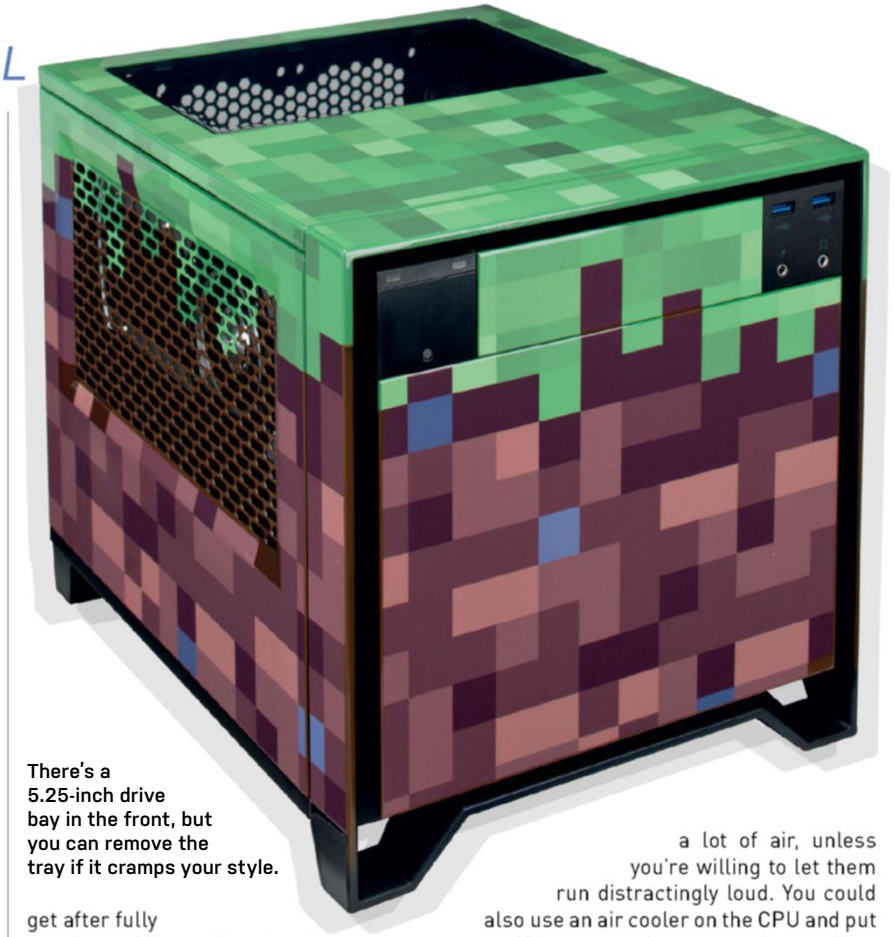
DON'T WALK ON THE GRASS

IT'S ARMED AND FULLY OPERATIONAL

Playing with itsy-bitsy computers is fun and all, but enthusiasts like us will always yearn for a little more power. Well, the Corsair Obsidian 250D case puts few restrictions on the size of your video card or power supply, accommodates a 240mm radiator, and even has a window on the top so you can peek inside. Bingo!

We gathered our own team of super heroes: A GeForce GTX 780 Ti, Intel Core i7-4770K, Asus ROG motherboard, Enermax Liqtech 240 cooler, and a Seasonic G-series power supply. This is very similar to September's "Build It" rig. A key difference is the motherboard. We actually went back a step to Intel's older Z87 chipset. That's because, as this issue went to press, there was no high-end mini-ITX Z97 motherboard, and we wanted to ensure a high overclock, since *Minecraft* does respond to higher CPU clock speeds (though we received the Maximus VII Impact after we finished our build). We'd need all the clocks we could get after fully tweaking *Minecraft*'s visuals, as those shaders do a number on your frame rate.



There's a 5.25-inch drive bay in the front, but you can remove the tray if it cramps your style.

INGREDIENTS

	Part	Price
Case	Corsair Obsidian Series 250D	$85
PSU	SeaSonic G Series SSR-550RM 550w	$80
Mobo	Asus Maximus VI Impact Z87	$230
CPU	Intel Core i7-4770K	$340
Cooler	Enermax Liqtech 240	$110
GPU	EVGA GeForce GTX 780 Ti 3GB 03G-P4-2881-KR	$680
RAM	2x8GB Corsair Vengeance Pro DDR3/1866	$185
HDD	Seagate Barracuda 3TB	$100
SSD	500GB Samsung 840 Evo	$250
OS	Windows 8.1 64-bit OEM	$100
Total		$2160

KEEPING OUR COOL

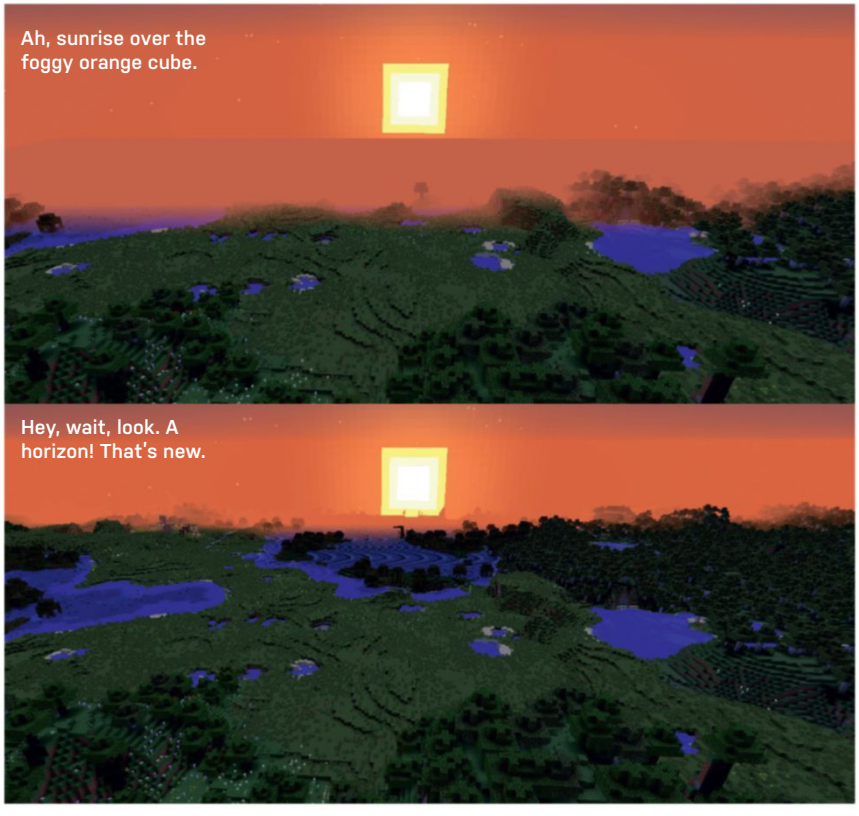
We could have gone with a Radeon R9 290 or 290X, which both perform in the neighborhood of a 780 Ti for less money, but we wanted a video card whose cooling design would vent most of the GPU's heat out the back of the case. That meant using the stock cooler, and Nvidia's run much quieter and cooler in this department than the stock R9 cards. It's true the Corsair 250D has two 80mm fan mounts in the rear, just above where the motherboard goes, but fans of that size just don't move a lot of air, unless you're willing to let them run distractingly loud. You could also use an air cooler on the CPU and put two 120mm case fans where the radiator would go, but you can get a higher CPU overclock with a 240mm liquid cooler.

Speaking of which, the eight-threaded Core i7-4770K is probably total overkill, since *Minecraft* uses just a couple of cores. We probably could have gotten away with using that 20th Anniversary Pentium CPU, which we've overclocked to 4.7GHz. On the other hand, the plethora of threads in our 4770K lets us do a much wider variety of things, such as encode a video in the background, or watch a 1080p movie on another monitor. It's very fancy.

Since this system stayed reliably above 60fps at 1080p with shaders loaded, there

DOUBLE UP WITH OPTIFINE

Even at its maximum, vanilla *Minecraft* can only load 16 chunks (world-high columns of 16x16 blocks) in all directions away from the camera, and your redstone contraptions will seize up if their chunk isn't loaded. Install Optifine and you can put your multi-core CPU and all that RAM to good use, doubling the chunks *Minecraft* can render at one time while keeping your frame rate slick. That's over a square kilometre of the world—and the redstone within it—loaded at any one time. –AC



wasn't much to tweak, or so it seemed. At 4K, we hovered around 35fps, but we could push it to 40 after overclocking to 4.5GHz on all cores. However, we dug around again for other shader packs, and this time we stumbled on one called "CUDA Shaders." It doesn't actually use Nvidia's CUDA technology, and it's not as pretty as SEUS to our eyes, but it's still much neater looking than the vanilla game, and it let us maintain 60fps even at Ultra HD resolution. We picked it up on the creator's website, http://dedelner.de.tl. You may actually prefer it over SEUS, so it's definitely worth a look.

THE LEARNING CURVE

Of these three builds, it's the GTX 760 that we actually had the most fun with. The Cooler Master Elite 110 is a neat little case and fits an impressive amount of stuff. It actually has more storage-device mounting points than the much larger Corsair 250D. And not putting a top-end GPU in the box forced us to get under the hood with graphical settings and figure out what was going on, so we learned more about the game and about GPU behavior than we would have otherwise. And as they say, knowing is half the battle.

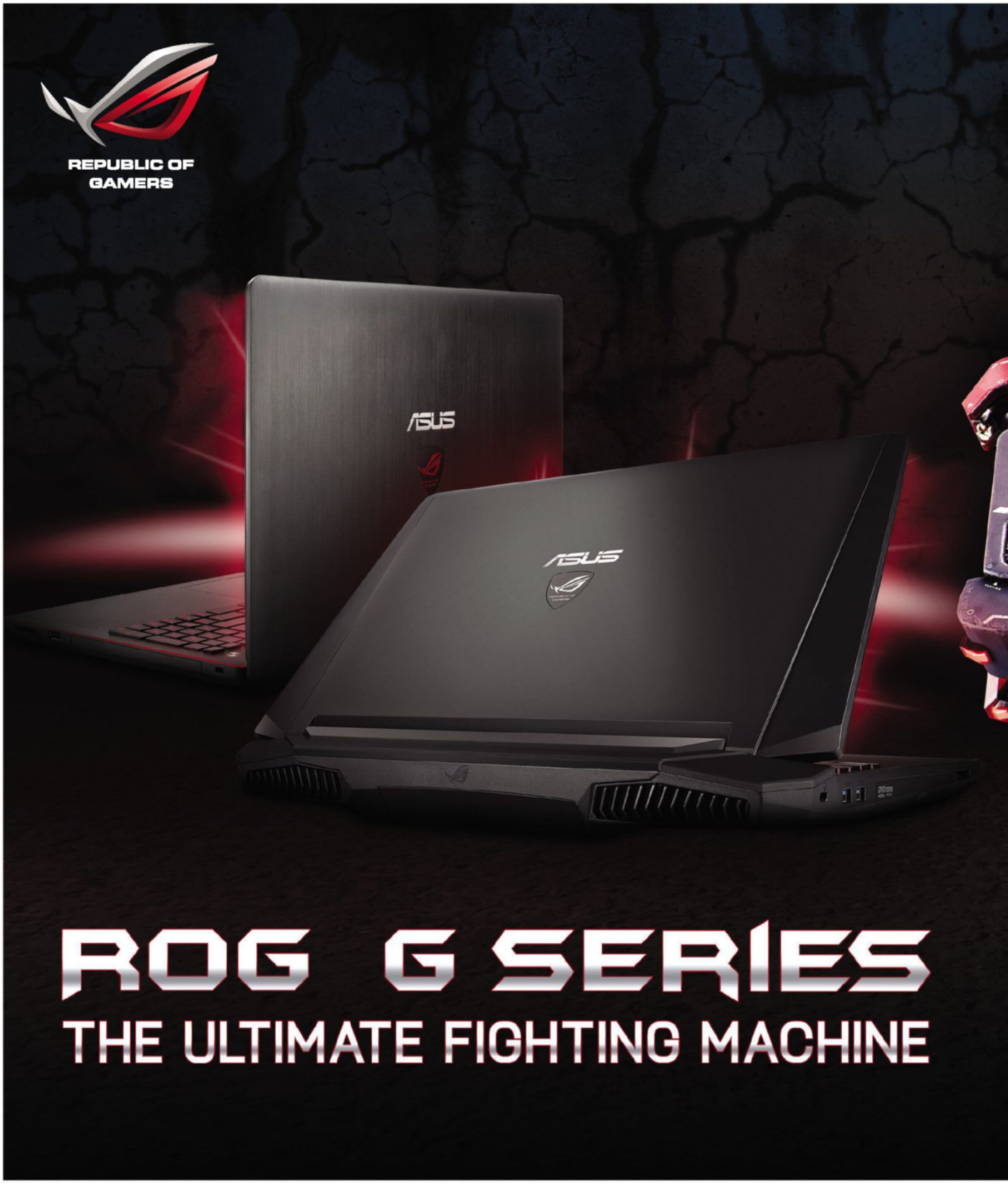
THE PAINTER

Much of the magic with our three ultimate *Minecraft* builds isn't necessarily the parts inside, it's what's on the outside. The exquisite paint jobs turned otherwise sedate cubes into real-life representations of *Minecraft*. When it came to getting it done, we turned to none other than the Michelangelo of case painting: Jim Sailing at Smooth Creations. We've featured Jim's work in *Maximum PC* before—he's painted numerous Dream Machines for us over the years—so we knew he was capable of shooting our *Minecraft* builds systems.

What we didn't expect, though, were the spectacular results. It may be a little hard to tell from our photographs, but these *Minecraft* machines are gorgeous. Besides the 8-bit aesthetic that transforms our rigs, Smooth Creations hit each box with multiple layers of clear coat to give them a paint job that's easily smoother than the one on your car. But Jim "Smooth" Sailing doesn't just shoot PC cases though—his company will beautify laptops, game consoles, and even guitars.

The cost of having a case painted isn't as crazy as you might think. Smooth Creations apply custom paint or hydro-dipped exteriors for $200 to $400, depending on the complexity of the job—Smooth Creations has to sometimes tear a case down to its base components in order to paint it properly. Visit www.smoothcreationsonline.com for more information. **–GU**

> "The plethora of threads in our 4770K lets us do a much wider variety of things. It's very fancy."



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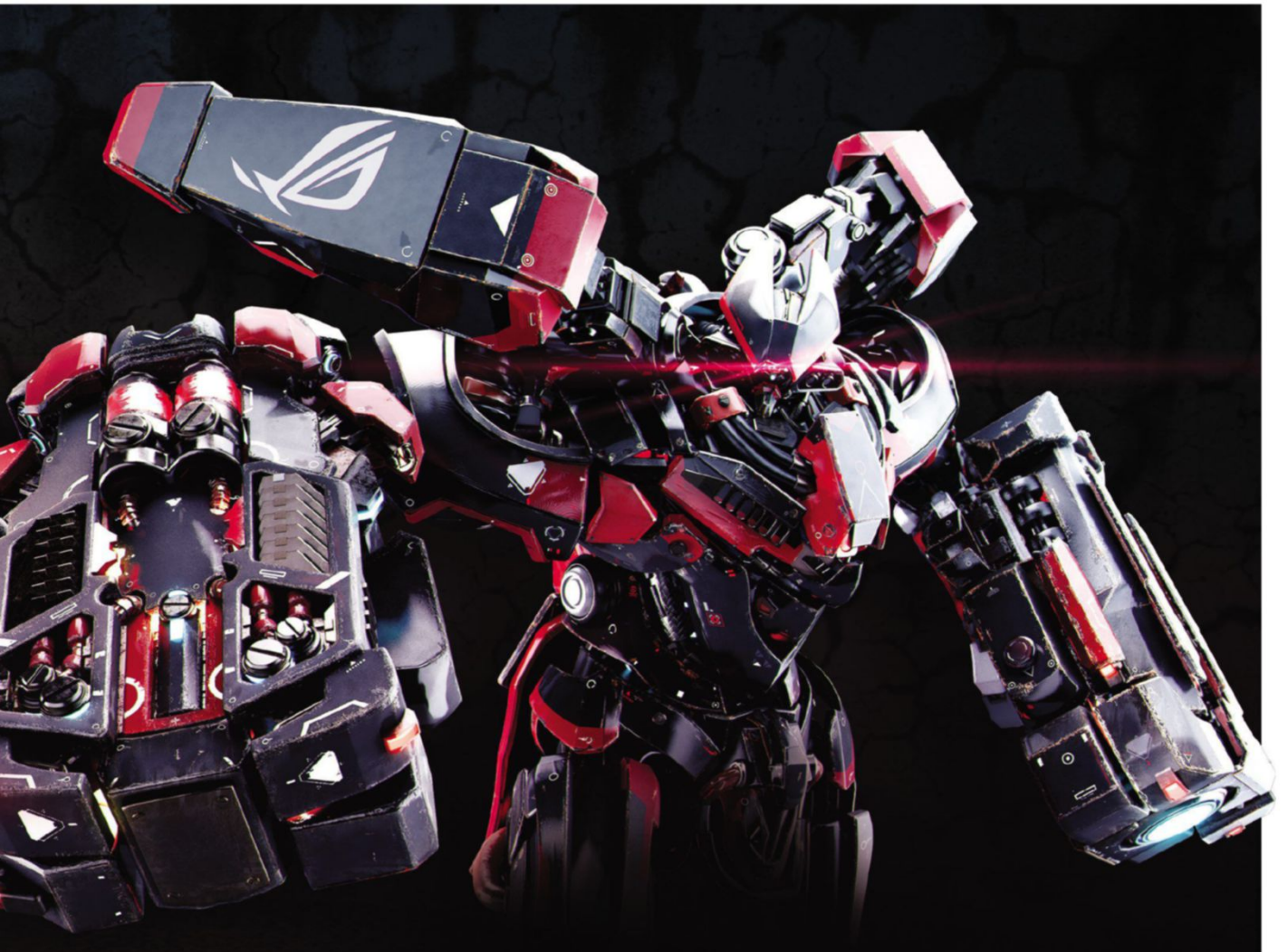
ASUS recommends Windows.



BREAKING THE BARRIERS

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Haswell-E:

Intel's Super CPU

Meet the new eight-core game-changing chip

by Gordon Mah Ung

After three long years of going hungry with six cores, red meat is finally back on the menu for enthusiasts. And not just any gamey slab full of gristle with shared cores, either. With its new eight-core Haswell-E CPU, Intel may have served up the most mouth-watering, beautifully seared piece of red meat in a long time.

And it's a good thing, too, because enthusiast's stomachs have been growling. Devil's Canyon? That puny quad-core was just an appetizer. And that dual-core highly overclockable Pentium K CPU? It's the mint you grab on your way out of the steak house.

No, what enthusiasts have craved and wanted—ever since Intel's original clock-blocking job on the original Sandy Bridge-E—is a true, overclockable enthusiast chip with eight cores. So if you're ready for a belt loosening belly full of enthusiast-level prime rib, pass the horseradish, get that damned salad off our table, and read on to see if Intel's Haswell-E is everything we hoped it would be.

> "Intel has served up the most mouth-watering piece of red meat in a long time.

MEET THE HASWELL-E PARTS

CPU	Base Clock (GHz)	Turbo Clock (GHz)	Cores/ Threads	Cache	PCIe Lanes	Memory Support	TDP	Price
Core i7-5960X	3.0	Up to 3.5	8/16	20MB	40	Quad-channel DDR4-2133	140W	$999
Core i7-5930K	3.5	Up to 3.7	6/12	15MB	40	Quad-channel DDR4-2133	140W	$583
Core i7-5820K	3.3	Up to 3.6	6/12	15MB	28	Quad-channel DDR4-2133	140W	$389

The wait is over:

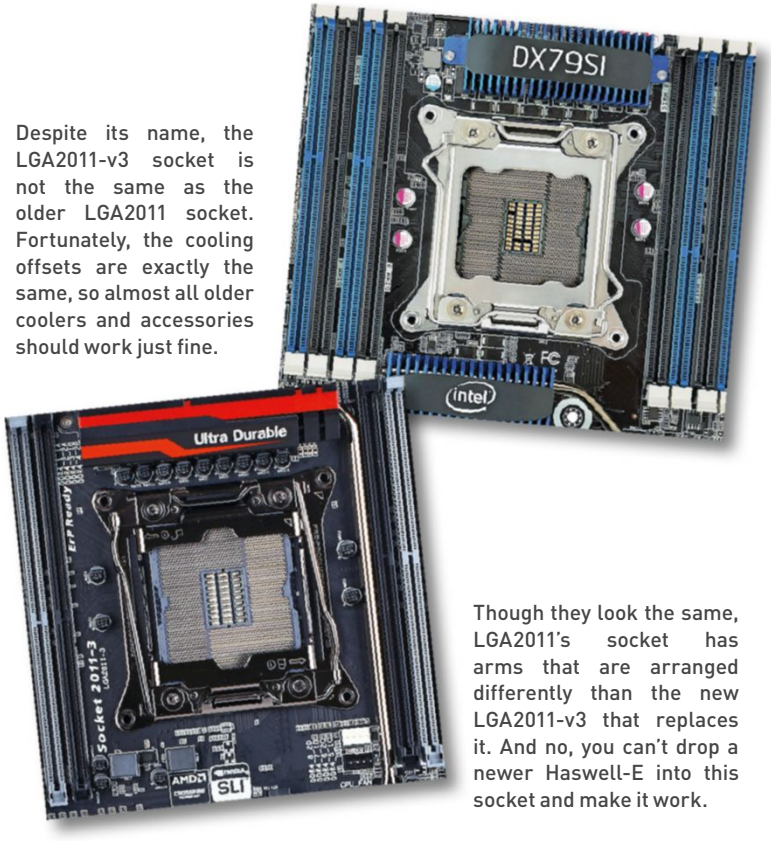
Haswell-E

The first consumer Intel eight-core arrives at last

Being a member of the PC enthusiast class is not an easy path to follow. Sure, you get the most cores and priciest parts, but it also means you wait a hell of a long time between CPU upgrades. And with Intel's cadence the last few years, it also means you get the leftovers. It's been that way since Intel went with its two-socket strategy with the original LGA1366/LGA1156. Those who picked the big-boy socket always got the shaft.

The original Ivy Bridge in LGA1156 socket, for example, hit the streets in April of 2012. Intel then rewarded the small-socket crowd with its Haswell in June of 2013. It wasn't until September of 2013 that big-boy socket users got Ivy Bridge-E for their LGA2011s. But with Haswell already tearing up the benchmarks, who the hell cared?

Well, that time has come with Haswell-E, Intel's first replacement for the aging LGA2011 platform since 2011. For the first time since the original Pentium 4 Extreme Edition, paying the premium price actually nets you more: namely, the company's first consumer eight-core CPU.



Despite its name, the LGA2011-v3 socket is not the same as the older LGA2011 socket. Fortunately, the cooling offsets are exactly the same, so almost all older coolers and accessories should work just fine.

Though they look the same, LGA2011's socket has arms that are arranged differently than the new LGA2011-v3 that replaces it. And no, you can't drop a newer Haswell-E into this socket and make it work.

Meet the T-Rex of consumer CPUs:

The Core i7-5960X

Overclocking to 4.5GHz and beyond

We were a little leery of Haswell when it first launched last year. It was, after all, a chip seemingly tuned for the mobile/laptoppy world we were told was our post-PC apocalyptic future. Despite this, we recognized the chip as the CPU to have for new system builders. Clock for clock, its 22nm process tri-gate transistors put everything else to shame—even the six-core Core i7-3930K chip in many tasks. So it's no surprise that when Intel took a quad-core Haswell, put it in the Xerox machine, and hit the copy button, we'd be ecstatic. Eight cores are decidedly better than six or four cores when you need them.

The cores don't come without a cost though, and we don't mean the usual painful price Intel asks for its highest-end CPUs. It's no secret that more cores means more heat, which means lower clock speeds. That's one of the rationales Intel used with the original six-core Core i7-3960X. Although sold as a six-core, the original Sandy Bridge-E was built using an eight-core die on which Intel had switched off two cores. Intel said it wanted to balance the needs of the many versus the needs of the few—that is, by turning off two of the cores, the part could hit higher clock speeds. Indeed, the Core i7-3960X had a base clock of 3.3GHz and Turbo Boost of 3.9GHz, and most could overclock it to 5GHz. The same chip packaged as a Xeon with all eight cores working—the Xeon E5-2687W—was locked down at 3.1GHz and mostly buzzed along at 3.4GHz.

Fully unlocked

With the new Core i7-5960X—the only eight-core of the bunch—the chip starts at a seemingly pedestrian 3GHz with a Turbo Boost of one core up to 3.5GHz. Those subsonic clock speeds won't impress against the Core i7-4790K, which starts at 4GHz. You'll find more on how well Haswell-E performs against Haswell in our performance section, but that's the price to be paid, apparently, to get a chip with this many cores under the heat spreader. Regarding thermals, Intel has increased the TDP rating to 140 watts versus the 130 watts of Ivy Bridge-E and Sandy Bridge-E.

If the low clocks annoy you, the good news is the part is fully unlocked, so overclocking has been approved. For our test units, we had tight deadlines, so didn't get far with our overclocking efforts. But talking with vendors, most seem pleased with the clock speeds they're seeing. One vendor told us overclocks of all cores at 4.5GHz are already obtainable, with newer microcode updates expected to improve that. With even the Devil's Canyon Core i7-4790K topping out at 4.7GHz to 4.8GHz, a 4.5GHz is actually a healthy overclock for an eight-core CPU.

When you dive down into the actual cores though, much is the same, of course. It's based on a 22nm process. It has "3D" tri-gate transistors and integrated voltage regulation. Oh, and it's also the first CPU to feature an integrated DDR4 memory controller.

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DDR4 Details

The memory stalemate is over

If you think Haswell-E has been a long wait, just think about DDR3, which made its debut as main memory in 2007 systems. Yes, 2007. The only component that's lasted seven years in most enthusiasts' systems might be the PSU, but it's even rare to find anyone kicking a 500-watt PSU from 2007 these days.

DDR4 has been in gestation seemingly as long, so why the delay? From what we can tell, resistance to yet another new memory standard when people thought the PC was dying has been the root delay. And it didn't help that no one wanted to stick their head out first. RAM makers didn't want to begin producing DDR4 in volume until AMD or Intel made chipsets for it, while AMD and Intel didn't want to support it because of the costs it would add to PCs. The stalemate finally ends with Haswell-E, which integrates a quad-channel DDR4 memory controller into its die.

Initial launch speeds of DDR4 clock in at DDR4/2133. For those already running DDR3 at 3GHz or higher, a 2,133 data rate is a snooze, but you should realize that anything over 2,133 is overclocked RAM. With DDR4, the JEDEC speeds (the body that sets RAM standards) already has target data rates of 3,200 on the map. RAM vendors we've talked to are already shopping DIMMS near that speed.

But the best part of DDR4 may be its density message. For years, consumer DDR3 has topped out at 8GB on a DIMM. With DDR4, we should see 16B DIMMs almost immediately, and stacking of chips is built into the standard, so it's possible we'll see 32GB DIMMs over its lifetime. On a quad-channel, eight-DIMM motherboard, you should expect to be able to build systems with 128GB of RAM using non-ECC DIMMs almost immediately. DDR4 also brings power savings and other improvements, but the main highlights enthusiasts should expect are higher densities and higher clocks. Oh, and higher prices. RAM prices haven't been fun for anyone of late, but DDR4 will definitely be a premium part for some time. In fact, we couldn't even get exact pricing from memory vendors as we were going to press, so we're bracing for some really bad news.

PCIe Lanes

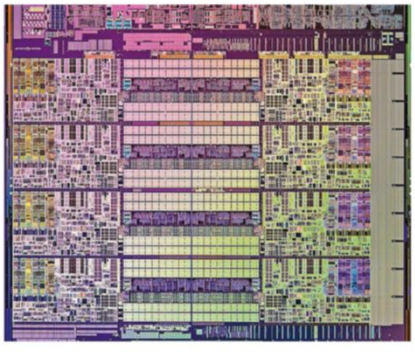
Now a feature to be blocked

Over the years, we've come to expect Intel to clock-block core counts, clock speeds, Hyper-Threading, and even cache for "market segmentation" purposes. What that means is Intel has to find ways to differentiate one CPU from another. Sometimes that's by turning off Hyper-Threading (witness Core i5 and Core i7) and sometimes its by locking down clock speeds. With Haswell-E though, Intel has gone to new heights with its clock-blocking by actually turning off PCIe lanes on some Haswell-E parts.

At the top end, you have the 3GHz Core i7-5960X with eight cores. In the midrange you have the six-core 3.5GHz Core i7-5930K. And at the "low-end" you have the six-core 3.3GHz Core i7-5820K. The 5930K and the 5820K are virtually the same in specs except for one key difference: The PCIe lanes get blocked. Yes, while the Core i7-5960X and Core i7-5930K get 40 lanes of PCIe 3.0, the Core i7-5820K gets an odd 28 lanes of PCIe 3.0. That means those who hoped to build "budget" Haswell-E boxes with multiple GPUs may have to think hard about using the lowest-end Haswell-E chip. The good news is that for most people, it won't matter. Plenty of people run Haswell systems with SLI or CrossFire, and those CPUs are limited to 16 lanes. Boards with PLX switches even support four-way GPU setups.

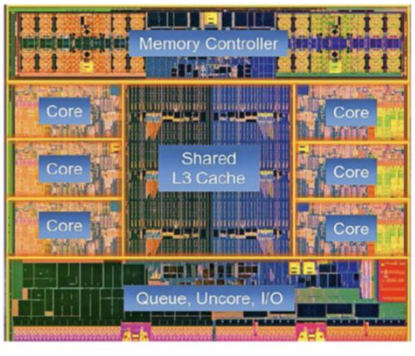
> "Those who hoped to build 'budget' Haswell-E boxes may have to think hard.

Still, it's a brain bender to think that when you populate an X99 board with the lowest-end Haswell-E, the PCIe configuration will change. At least they'll work, just more slowly. Intel says it worked with board vendors to make sure all the slots will function with the budget part.



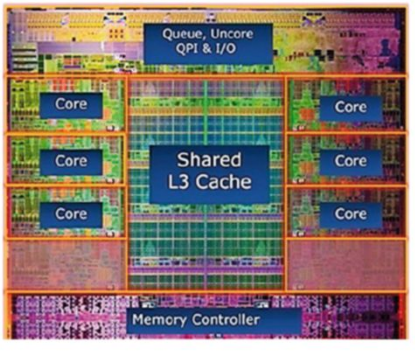
HASWELL-E

There have been clock-blocking rumors swirling about the Haswell being a 12-core Xeon with four cores turned off. That's not true and Intel says this die-shot proves it.



IVY BRIDGE-E

Ivy Bridge-E's main advantage over Sandy Bridge-E was a native six-core die and reduced power consumption. But overclocking yields were greatly reduced.



SANDY BRIDGE-E

Sandy Bridge-E and Sandy Bridge will long be remembered for its friendliness to overclocking and having two of its working cores killed Red Wedding–style by Intel.

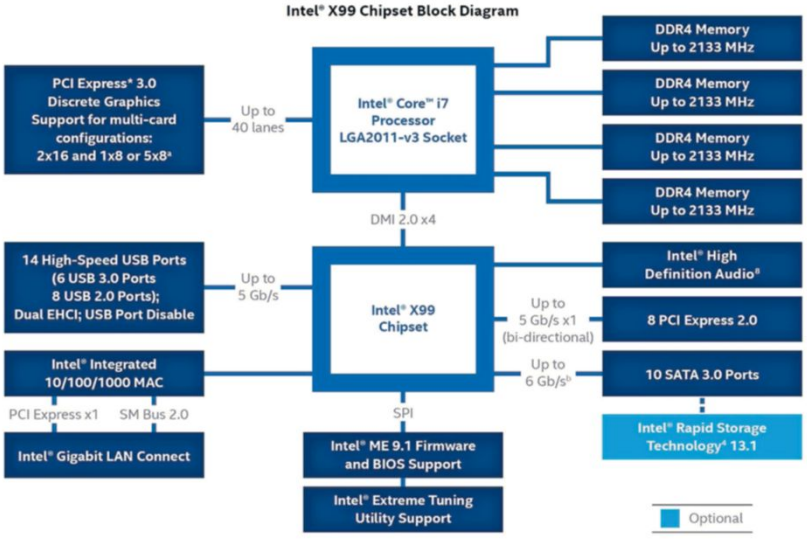
X99

Finally, the chipset high-end enthusiasts want, sort of

You know what we won't miss? The X79 chipset. No offense to X79 owners, while the Core i7-4960X can stick around for a bit, X79 can take its under-spec'ed butt out of our establishment. Think we're being too harsh? We don't.

X79 has no native USB 3.0 support. And its SATA 6Gb/s ports? Only two. It almost reads like a feature set from the last decade. Fortunately, Intel has gone hog wild in over-compensating for the weaknesses of X79.

X99 has eight USB 2.0 ports and six USB 3.0 ports. For SATA 6Gb/s, Intel adds 10 ports to X99. Yes, 10. That gazongo number, however, is balanced out by two glaring omissions: no official SATA Express or M.2 support that came with Z97. Intel would only say motherboard vendors were free to implement it. We guess Intel left the feature off as the firm is a stickler for testing new interfaces before adding official support. At this point, SATA Express has been a no-show. After all, motherboards with SATA Express became available in May with Z97, yet we still haven't seen any native SATA Express drives. We expect most vendors to simply add it through discrete controllers.


Intel® X99 Chipset Block Diagram
PCI Express® 3.0 Discrete Graphics Support for multi-card configurations: 2x16 and 1x8 or 5x8a
Up to 40 lanes
Intel® Core™ i7 Processor LGA2011-v3 Socket
DDR4 Memory Up to 2133 MHz
DDR4 Memory Up to 2133 MHz
DDR4 Memory Up to 2133 MHz
DDR4 Memory Up to 2133 MHz
DMI 2.0 x4
14 High-Speed USB Ports (6 USB 3.0 Ports 8 USB 2.0 Ports); Dual EHCI; USB Port Disable
Up to 5 Gb/s
Intel® X99 Chipset
Intel® High Definition Audio8
Up to 5 Gb/s x1 (bi-directional)
8 PCI Express 2.0
Intel® Integrated 10/100/1000 MAC
Up to 6 Gb/sb
10 SATA 3.0 Ports
PCI Express x1
SM Bus 2.0
SPI
Intel® Rapid Storage Technology4 13.1
Intel® Gigabit LAN Connect
Intel® ME 9.1 Firmware and BIOS Support
Intel® Extreme Tuning Utility Support
Optional

Intel overcompensated with SATA on X99 but left SATA Express on the cutting-room floor.

One potential weakness of X99 is Intel's use of the DMI 2.0. That offers roughly 2.5GB/s of transfer speed between the CPU and the south bridge or PCH, but with the board hanging 10 SATA devices, USB 3.0, Gigabit Ethernet, and 8 PCIe Gen 2.0 lanes off that link, there's potential for massive congestion in a worst-case scenario. But, says Intel, you can just hang devices off the plentiful PCIe Gen 3.0 from the CPU.

That does bring up our last point: the PCIe lanes. There will be confusion over the PCIe lane configuration on systems with Core i7-5820K parts. With only 28 lanes available, there's concern whole slots will be turned off. That won't happen, Intel says. Instead, if you go with the low-rent ride, you simply lose bandwidth, but will still have more than you can get from a normal LGA1150-based Core i7-4770K. It will be confusing, but we expect motherboard vendors to sort it out.

Haswell-E does bring one more interesting PCIe configuration—the ability to run five graphics cards in the PCIe slots at x8 speeds. What for? Intel didn't explain. Maybe mining configurations where miners are already running six GPUs. But mining doesn't seem to need the bandwidth that a x8 slot would provide. The other possibility is a five-way graphics card configuration being planned by Nvidia or AMD. At this point it's just conjecture, but one thing we know is that X99 is a welcome upgrade. Good riddance X79.

TOP PROCS COMPARED

	Core i7-5960X	Core i7-4960X	Core i7-3960X	Core i7-990X	Core i7-4790K	Core i7-3770K
Codename	Haswell-E	Ivy Bridge-E	Sandy Bridge-E	Gulftown / Westmere	Devil's Canyon / Haswell	Ivy Bridge
Clock	3GHz-3.5GHz	3.6GHz-3.9GHz	3.6GHz-3.9GHz	3.46GHz-3.7GHz	4GHz-4.4GHz	3.5GHz-3.9GHz
Core/Thread	8/12	6/12	6/12	6/12	4/8	4/8
Transistor Count	2.6 billion	1.86 billion	2 billion	1.17 billion	1.6 billion	1.4 billion
Die Size	355.5mm²	257mm²	435mm²	240mm²	177mm²	160mm²
L2 Cache	2MB	1.5MB	1.5MB	1.5MB	1MB	1MB
L3 Cache	20MB	15MB	15MB	12MB	8MB	8MB
Process	22nm	22nm	32nm	32nm	22nm	22nm
TDP	140 watts	130 watts	130 watts	130 watts	88 watt	77 watt
Socket	LGA2011-v3	LGA2011	LGA2011	LGA1366	LGA1150	LGA1155
Integrated Memory Controller	Quad-ch. DDR4	Quad-ch. DDR3	Quad-ch. DDR3	Triple-ch. DDR3	Dual-ch. DDR3	Dual-ch. DDR3

Core Competency

How many cores do you *really* need?

Like great technology philosopher Sir Mix-A-Lot says, we like big cores and we cannot lie. We want as many cores as legally available. But we recognize that not everyone rolls as hard as we do with a posse of threads. With Intel's first eight-core CPU, consumers can now pick from two cores all the way to eight on the Intel side of the aisle—and then there's Hyper-Threading to confuse you even more. So, how many cores do you need? We'll give you the quick-and-dirty lowdown.

Two cores

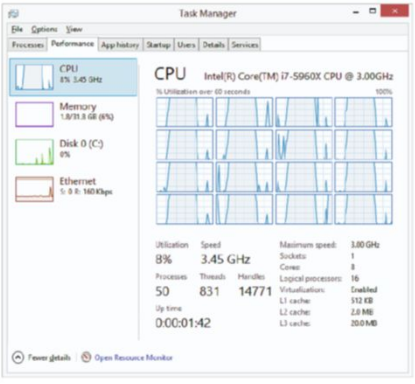
Normally, we'd completely skip dual-cores without Hyper-Threading because the parts tend to be the very bottom end of the pool Celerons. Our asterisk is the new Intel Pentium G3258 Anniversary Edition, or "Pentium K," which is a real hoot of a chip. It easily overclocks and is dead cheap. It's not the fastest in content creation by a long shot, but if we were building an ultra-budget gaming rig and needed to steal from the CPU budget for a faster GPU, we'd recommend this one. Otherwise, we see dual-cores as purely ultra-budget parts today.

Two cores with Hyper-Threading

For your parents who need a reliable, solid PC without overclocking (you really don't want to explain how to back down the core voltage in the BIOS to grandma, do you?), the dual-core Core i3 parts fulfill the needs of most people who only do content creation on occasion. Hyper-Threading adds value in multi-threaded and multi-tasking jobs. You can almost think of these chips with Hyper-Threading as three-core CPUs.

Four cores

For anyone who does content creation such as video editing, encoding, or even photo editing with newer applications, a quad-core is usually our recommended part. Newer game consoles are also expected to push minimum specs for newer games to quad-cores or more as well, so for most people who carry an Enthusiast badge, a quad-core part is the place to start.



It's indeed a glorious thing to see a task manager with this many threads, but not everyone needs them.

Four cores with Hyper-Threading

Hyper-Threading got a bad name early on from the Pentium 4 and existing software that actually saw it reduce performance when turned on. Those days are long behind us though, and Hyper-Threading offers a nice performance boost with its virtual cores. How much? A 3.5GHz Core i7 quad-core with Hyper-Threading generally offers the same performance on multi-threaded tasks as a Core i5 running at 4.5GHz. The Hyper-Threading helps with content creation and, we'd say, if content creation is 30 percent or less of your time, this is the place to be. It's the best fit for 90 percent of enthusiasts.

Six cores with Hyper-Threading

Once you pass the quad-core mark, you are moving pixels professionally in video editing, 3D modeling, or other tasks that necessitate the costs of a six-core chip or more. We still think that for 90 percent of folks, a four-core CPU is plenty, but if losing time rendering a video costs you money (or you're ADD), pay for a six-core or more CPU. How to decide if you need six or eight cores? Read on.

Eight cores with Hyper-Threading

Not everyone needs an eight-core processor. In fact, one way to save cash is to buy the midrange six-core chip. But, if time is money, an eight-core chip will pay for itself. For example, the eight-core Haswell-E is about 45 percent faster than the four-core Core i7-4790K chip. If your render job is three hours, that's more time working on other paying projects. The gap gets smaller between the six-core and the eight-core, so it becomes about how much your time is worth. To give you an idea, the 3.3GHz Core i7-5960X is about 20 percent faster than the Core i7-4960X running at 4GHz.

Intel's Top Guns Compared

The LGA2011-based Core i7-4960X (left) and the LGA2011-v3-based Core i7-5960X (middle) dwarf the Core i7-4790K chip (right). Note the change in the heat spreader between the older 4960X and 5960X, which now has larger "wings" to make it easier to remove the CPU. The breather hole, which allows for curing of the thermal interface material, has also been moved. Finally, while the chips are the same size, they're keyed differently to stop you installing a newer Haswell-E into an older Ivy Bridge-E board.

Benchmarks

Performance junkies, rejoice! Haswell-E hits it out of the ballpark

For our testing, we set up three identical systems with the fastest available CPUs for each platform. Each system used an Nvidia GeForce GTX 780 with the same 340.52 drivers, Corsair 240GB Neutron GTX SSDs, and 64-bit Windows 8.1 Enterprise. Since we've had issues with clock speeds varying on cards that physically look the same, we also verified the clock speeds of each GPU manually and also recorded the multiplier, bclock, and speeds the parts run at under single-threaded and multi-threaded loads.

So you know, the 3GHz Core i7-5960X's would run at 3.5GHz on single-threaded tasks but usually sat at 3.33GHz on multi-threaded tasks. The 3.6GHz Core i7-4960X ran everything at 4GHz, including multi-threading tasks. The 4GHz Core i7-4790K part sat at 4.4GHz on both single- and multi-threaded loads.

For Z97, we used a Gigabyte Z97M-D3H mobo with a Core i7-4790K "Devil's Canyon" chip aboard. An Asus Sabertooth X79 did the duty for our Core i7-4960X "Ivy Bridge-E" chip. Finally, for our Core i7-5960X chip, we obtained an early Gigabyte X99-Gaming 5 motherboard. The board was pretty early but we feel comfortable with our performance numbers as Intel has claimed the Core i7-5960X was "45 percent" faster than a quad-core chip, and that's what we saw in some of our tests.

One thing to note: The RAM capacities were different but in the grand scheme of things and the tests we ran, it has no impact. The Sabertooth X79 had 16GB of DDR3/2133 in quad-channel mode, the Z97M-D3H had 16GB of DDR3/2133 in dual-channel mode. Finally, the X99-Gaming 5 board had 32GB of Corsair DDR4/2133. All three CPUs will overclock, but we tested at stock speeds to get a good baseline feel.

For our benchmarks, we selected from a pile of real-world games, synthetic tests, as well as real-world applications across a wide gamut of disciplines. Our gaming tests were also run at very low resolutions and low-quality settings to take the graphics card out of the equation. We also acknowledge that people want to know what they can expect from the different CPUs at realistic settings and resolutions, so we also ran all of the games at their highest settings at 1920x1080 resolution, which is still the norm in PC gaming.

The results

We could get into a multi-sentence analysis of how it did and slowly break out with our verdict but in a society where people get impatient at the microwave, we'll give you the goods up front: Holy Frakking Smokes, this chip is fast! The Core i7-5960X is simply everything high-end enthusiasts have been dreaming about.

Just to give you an idea, we've been recording scores from $7,000 and $13,000 PCs in our custom Premiere Pro CS6 benchmark for a couple of years now. The fastest we've ever seen is the Digital Storm Aventum II that we reviewed in our January 2014 issue. The 3.3GHz Core i7-5960X was faster than the Aventum II's Core i7-4960X running at 4.7GHz. Again, at stock speeds, the Haswell-E was faster than the fastest Ivy Bridge-E machine we've ever seen.

It wasn't just Premiere Pro CS6 we saw that spread in either. In most of our tests that stress multi-threading, we saw roughly a 45 to 50 percent improvement going from the Haswell to the Haswell-E part. The scaling gets tighter when you're comparing the six-core Core i7-4960X, but it's still a nice, big number. We generally saw a 20 to 25 percent improvement in multi-threaded tasks.

We used a Gigabyte X99 motherboard (without the final heatsinks for the voltage-regulation modules) for our testing.

That's not even factoring in the clock differences between the parts. The Core i7-4790K buzzes along at 4.4GHz—1.1GHz faster than the Core i7-5960X in multi-threaded tasks—yet it still got stomped by 45 to 50 percent. The Core i7-4960X had a nearly 700MHz clock advantage as well over the eight-core chip.

The whole world isn't multi-threaded, though. Once we get to workloads that don't push all eight cores, the higher clock speeds of the other parts predictably take over. ProShow Producer 5.0, for example, has never pushed more than four threads and we saw the Core i7-5960X lose by 17 percent. The same happened in our custom Stitch.EFx 2.0 benchmark, too. In fact, in general, the Core i7-4790K will be faster thanks to its clock speed advantage. If you overclocked the Core i7-5960X to 4GHz or 4.4GHz on just four cores, the two should be on par in pure performance on light-duty workloads.

In gaming, we saw some results from our tests that are a little bewildering. At low-resolution and low-quality settings, where the graphics card was not the bottleneck, the Core i7-4790K had the same 10 to 20 percent advantage. When we ran the same tests at ultra and 1080p resolution, the Core i7-5960X actually had a slight advantage in some of the runs against the Core i7-4790K chip. We think that may be from the bandwidth advantage the 5960X has. Remember, we ran all of the RAM at 2,133, so it's not DDR4 versus DDR3. It's really quad-channel versus dual-channel.

We actually put a full breakdown of each of the benchmarks and detailed analysis on www.maximumpc.com if you really want to nerd out on the performance.

What you should buy

Let's say it again: The Core i7-5960X stands as the single fastest CPU we've seen to

date. It's simply a monster for performance in multi-threaded tasks and we think that once you've overclocked it, it'll be as fast as all the others in tasks that aren't thread-heavy workloads.

But is it for you?

That performance, however, doesn't mean everyone should start saving to buy a $1,000 CPU. No, for most people, the dynamic doesn't change. For the 80 percent of you who fall into the average Joe or Jane nerd category, a four-core with Hyper-Threading still offers the best bang for the buck. It won't be as fast as the eight-core, but unless you're really working your rig for a living, made of money, or hate for your Handbrake encodes to take that extra 25 minutes, you can slum it with the Core i7-4790K chip. You don't even have to heavily overclock it for the performance to be extremely peppy.

For the remaining 20 percent who actually do a lot of encoding, rendering, professional photo editing, or heavy multi-tasking, the Core i7-5960X stands as the must-have CPU. It's the chip you've been waiting for Intel to release. Just know that at purely stock speeds, you do give up performance to the Core i7-4790K part. But again, the good news is that with minor overclocking tweaks, it'll be the equal or better of the quad-core chip.

What's really nice here is that for the first time, Intel is giving its "Extreme" SKU something truly extra for the $999 they spend. Previous Core i7 Extreme parts have always been good overclockers, but a lot of people bypassed them for the midrange chips such as the Core i7-4930K, which gave you the same core counts and overclocking to boot. The only true differentiation Extreme CPU buyers got was bragging rights. With Haswell-E, the Extreme buyers are the only ones with eight-core parts.

The upgrade dilemma

Bang-for-the-buck buyers also get a treat from the six-core Core i7-5820K chip. At $389, it's slightly more expensive than the chip it replaces—the $323 Core i7-4820K—but the extra price nets you two more cores. Yes, you lose PCIe bandwidth but most people probably won't notice the difference. We didn't have a Core i7-5820K part to test, but we believe on our testing with the Core i7-5960X that minor overclocking on the cheap Haswell-E would easily make it the equal of Intel's previous six-core chips that could never be had for less than $580.

And that, of course, brings us to the last point of discussion: Should you upgrade from your Core i7-4960X part? The easy answer to that is no. In pure CPU-on-CPU showdowns, the Core i7-4960X is about 20 percent slower in multi-threaded tasks, and in light-duty threads it's about the same, thanks to the clock-speed advantage the Core i7-4960X has. There are two reasons we might want to toss aside the older chip, though. The first is the pathetic SATA 6Gb/s ports, which, frankly, you actually need on a heavy-duty work machine. The second reason would be the folks for whom a 20 percent reduction in rendering time would actually be worth paying for.

> "It's the chip you've been waiting for. It's a monster.

BENCHMARKS

CPU	3GHz Core i7-5960X	4GHz Core i7-4790K	3.5GHz Core i7-4960X
Sandra Memory Bandwidth (GB/s)	40.1	27.7	**53.6**
Sandra L1 Cache (TB/s)	**1.7**	1.14	0.82
Sandra L2 Cache (GB/s)	**605.49**	407.6	520.19
Sandra L3 Cache (GB/s)	257.19	216	**301**
Cinebench 15 Multi-Threaded	**1,322**	889	1,087
Cinebench 15 Single-Threaded	140	**177**	146
POV-Ray (sec)	**97.2**	143	122
Premiere Pro CS6 (sec)	**1,538**	2,237	1,831
X264 HD 5.01 Pass 1 (fps)	**128**	94.2	114.2
X264 HD 5.01 Pass 2 (fps)	**28.2**	19.3	23.2
ProShow Producer 5.0 (sec)	1,453	**1,201**	1,469
Handbrake Encode (sec)	**676**	931	767
Stitch.Efx 2.0 (sec)	843	**727**	756
7-zip 64-bit 8MB/12Threads (MIPS)	31,625	26,226	**36,993**
7-zip 64-bit 8MB/16Threads (MIPS)	**38,030**	25,977	35,146
Fritz Chessmark	12,921	**16,958**	15,202
Valve Particle Test (fps)	281	245	**291**
3DMark Overall	**9,087**	8,811	**9,087**
3DMark GPU	9,819	9,783	**9,943**
3DMark Physics	**16,187**	12,554	15,208
Dirt 13x7 low (fps)	186.98	**229.38**	205.35
Dirt 19x10 ultra (fps)	**94.98**	89.4	91.79
Hitman: Absolution (fps) 13x7 Lowest	112.98	128.01	**130.27**
Hitman: Absolution (fps) 19x10 Ultra	87.24	94.5	**96.1**
Tomb Raider (fps) 13x7 Low	**524.7**	500.7	517.1
Tomb Raider (fps) 19x10 Ultimate	**76.8**	67.0	75.3
Metro Last Light (fps) 13x7 Low	161.0	159	**171.3**
Metro Last Light (fps) 19x10 Very High	36.33	41	**42.7**

Best scores are bolded.

No more TV for America?

There is a computer program (and mobile app) that can revolutionize the way *you* watch your TV programs and movies. It allows you to watch live and on-demand TV, worldwide, through your computer, TV or mobile devices, without any monthly fees.

At only $14.99 (a one-time deal for all devices; and no monthly fees), it can provide you access to over one million premium movies and shows and over 200,000 TV channels (mostly in HD); all listed by country and genre... and it keeps growing. This is something way beyond Cable, Satellite, Netflix or Hulu.

The software uses your Internet connection as the "antenna" or "satellite dish" to connect you to the hundreds of thousands of channels and over one million movies and shows. It can use your computer monitor as your TV screen or you can buy an HDMI cable, for a few extra bucks, in any electronics store, and connect your computer to your TV set for an even larger view. It's completely legal, according to FCC regulations. If you have either a computer, phone or TV (and a high-speed Internet connection), all you need is to download the software.

The official word is that a possible price increase is still being considered. But as of today, $14.99 for all devices is still the official offer. If you think about it, this could be your alternative to paid TV service.

To learn more, review the channel list or to obtain downloading information, please visit their official site, at: **MyTVforFree.com**

Master the Amazing Raspberry

Join the low-cost coding revolution that's creating a whole new generation of programmers

by Les Pounder

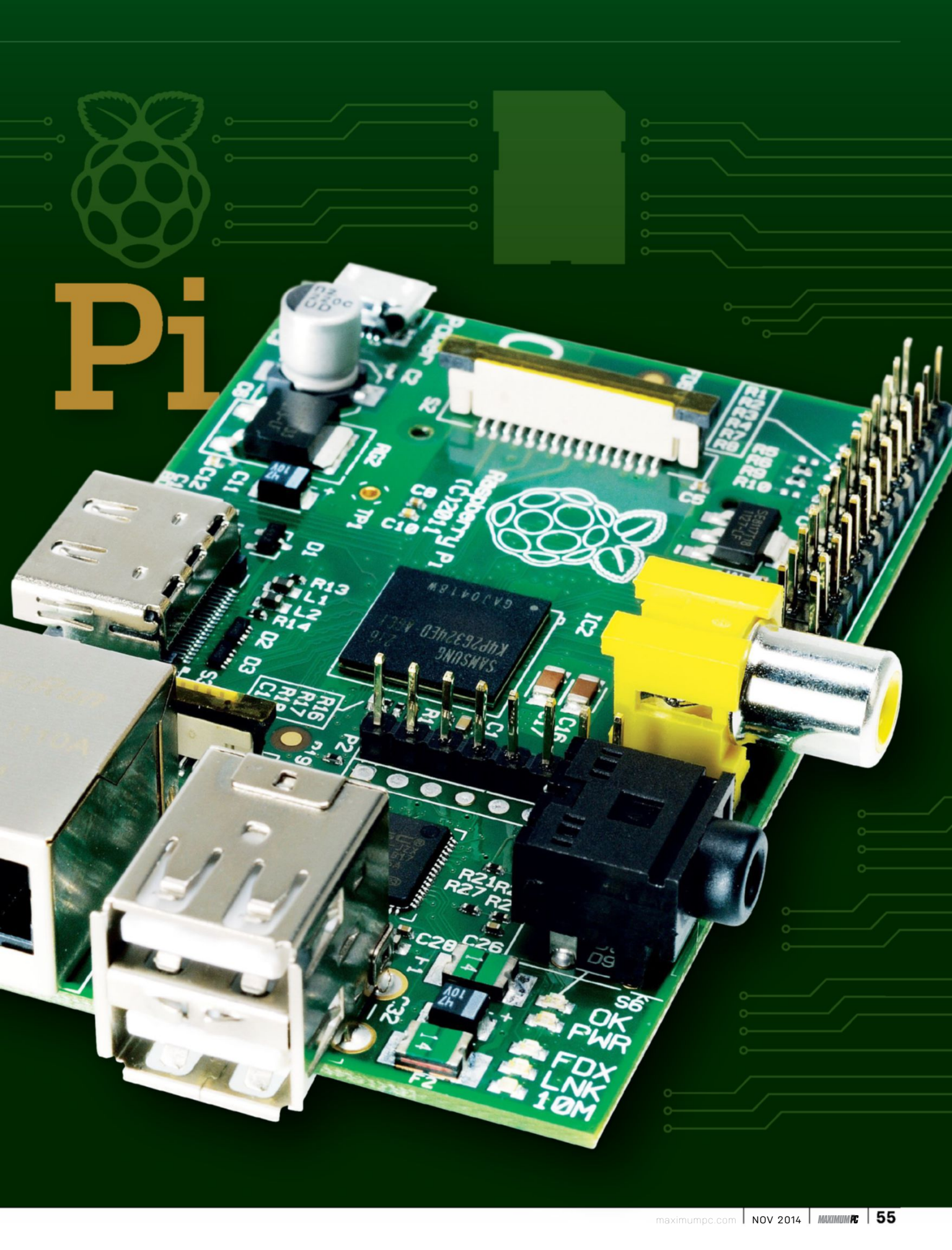
It's already been over two years since the Raspberry Pi burst onto the scene. The result? A small but significant shake-up of the broader computing landscape thanks to the growing impact of this delightfully diminutive device. Developed by the UK-based Raspberry Pi Foundation to address the falling number of students taking computer science, it's fair to say the University of Cambridge-based creators of this $25 mini-computer must be pretty happy with how things are going.

A couple of years on, we already have kids as young as six years old learning how to code courtesy of this low-cost computer. It's now becoming clear we're on the verge of a new generation of code-savvy children who are true digital natives, ready to take ownership of the Internet.

The impact, unsurprisingly, has been felt most sharply across the pond in the UK, where a genuinely pivotal change to the education system is starting to take shape. Looking back to the format of computer science classes before the RPi, these lessons generally focused on Microsoft Office applications, with some children progressing to web development. But classes have moved into a transitional period, with teachers reaching out to the open source communities to learn how to think like a programmer. We can see this in projects such as Simon Walters' Scratch-based robotics (http://cymplecy.wordpress.com). Some UK examining bodies, such as OCR, are now even incorporating coding and hacking into their syllabuses.

But it's not just the Brits having all the fun, as demand for the RPi in the U.S. grows towards critical mass. And for good reason. Enjoyable for all ages, it's made computing and electronics accessible due to its versatility and low cost. In this feature we'll take you through setting up your RPi, and along the way we'll learn new coding and hardware skills, therefore providing a solid foundation for future projects—so let's get hacking!

> "It's becoming clear we're on the verge of a new generation of code-savvy children ready to seize full ownership of the Internet.


Pi
SAMSUNG
OK
PWR
FDX
LNK
10M

Installing the Optimised Debian-based Raspbian Operating System on an RPi

The Raspberry Pi is powered by an ARM processor, running at 700MHz. While the RPi doesn't have a lot of processing muscle, it works well for learning how to code and hack. The RPi Model B has 512MB of memory—which is plenty for the recommended Raspbian operating system, a lightweight version of the Debian Linux OS for ARM processors.

The majority of users stick with Raspbian as the basis of their projects, and this has improved the OS and the level of support it has for external hardware. There are, however, other OSes for the Raspberry Pi. Turn the page to find out more about them.

Getting started

These days, downloading and installing the OS is a fairly routine task. The Raspberry Pi Foundation has released NOOBS (New Out Of Box Software), which is a downloadable zip file that contains a number of different operating systems (Pidora, Raspbian, and two flavors of XBMC) that can all be used with your Raspberry Pi via an SD card. To install Linux on your RPi, you'll need an SD card with at least 4GB of space, which has been formatted as FAT32. To download the 1.3GB NOOBS zip file, head over to www.raspberrypi.org/downloads.

Once the download is complete, insert your formatted SD card into your computer and extract the contents of the zip file to the card. Once complete, remove the card and insert it into your Raspberry Pi. Make sure that all the connections are correct, and then switch on the power. On first boot, NOOBS automatically loads a menu offering a choice of operating systems.

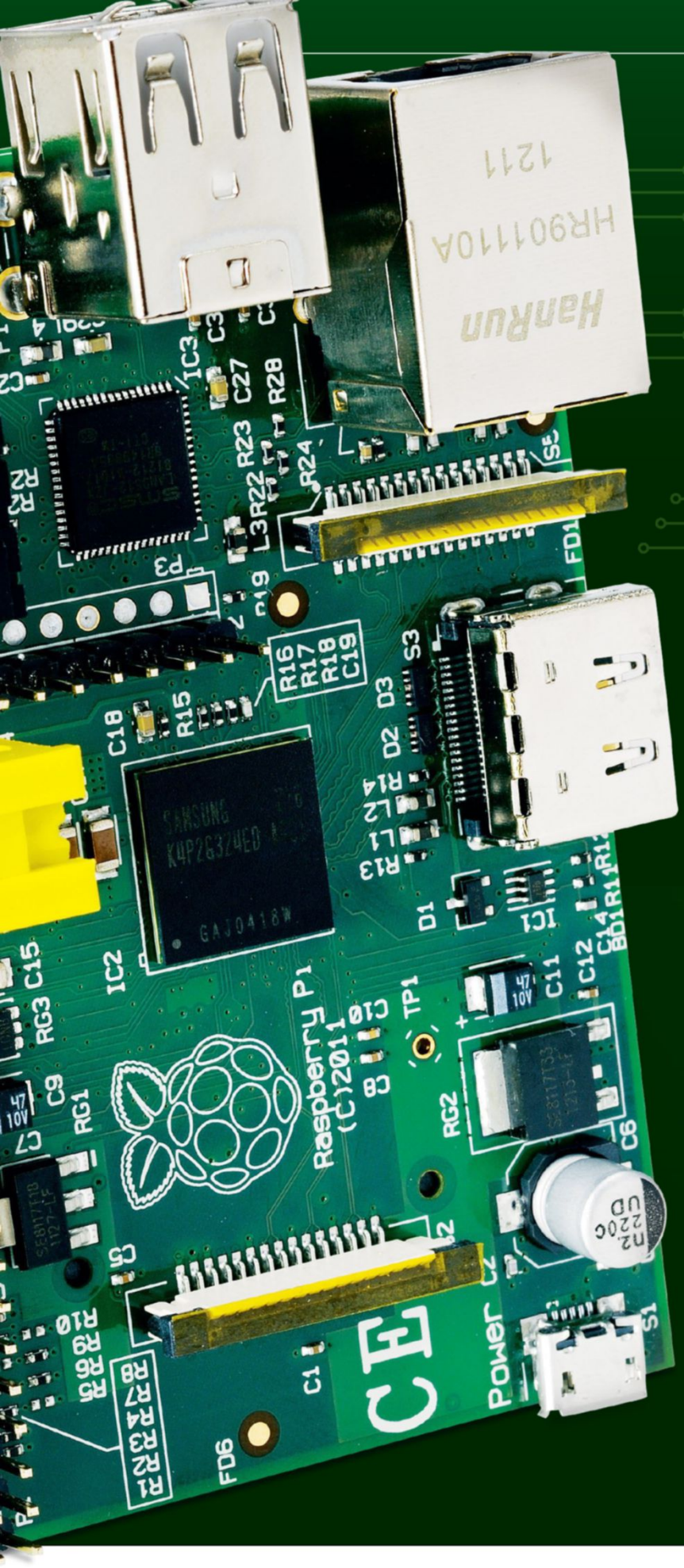
For this feature, we're focusing on Raspbian, so go ahead and select it from the menu and then click on "Install OS" from the menu bar. Once NOOBS has installed Raspbian on the SD card that you inserted into your RPi, it will ask you to reboot. Do so and let the RPi fully boot up.

Upon reboot, you'll be asked to log in. The default username is "pi" and the password is "raspberry." Once logged in, type the command "raspi-config," which opens a tool to update and configure your RPi. The first important thing to do from this screen is to update "raspi-config." For this you'll need a working Internet connection, and you'll need to change the boot behavior so your Raspberry Pi boots to desktop.

Once the update is complete, exit out of "raspi-config" and type "reboot" to reboot the RPi and load the changes you just made. Upon a successful reboot, your RPi will log straight into the LXDE desktop environment.

Once you've installed an operating system, you can return to the NOOBs interface at any time. You do this by holding down Shift during boot. This will enable you to try out other operating systems, or overwrite a corrupted SD card with a fresh install of Raspbian.

> "The Raspberry Pi Foundation has released a downloadable zip file that contains a number of different operating systems.



Installing Software

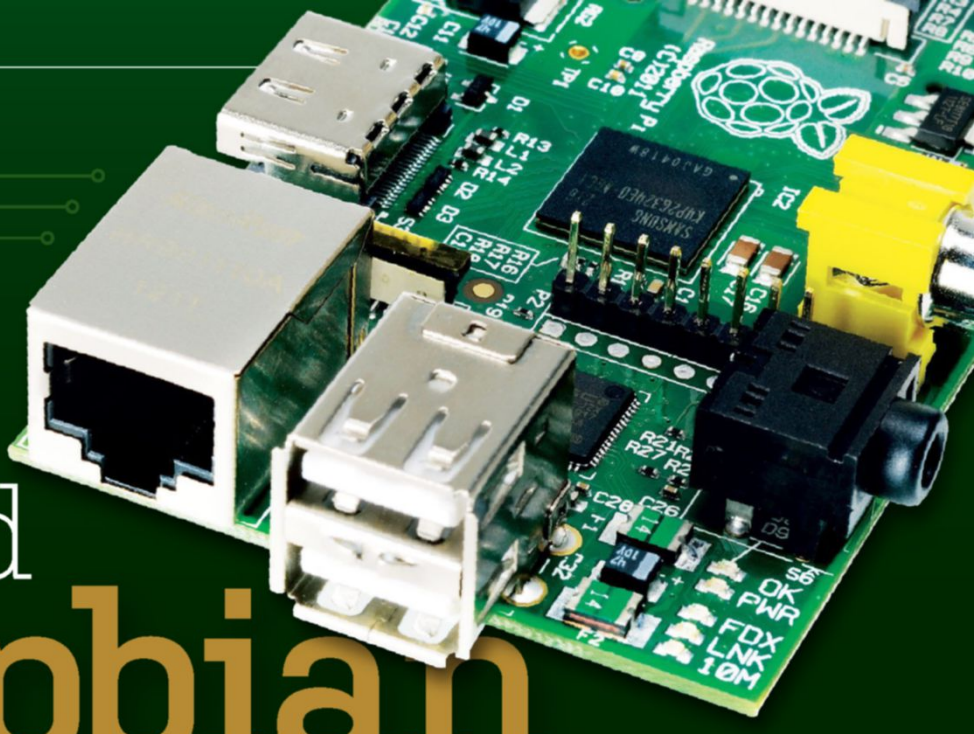
The Raspberry Pi is a typical Debian-based computer, which means you can install software packages directly via the terminal (listed in the Start menu) by using the "apt" command and tool.

Apt stands for the Advanced Packaging Tool and handles the installation, removal, and audit of all of the software. You'll need root permissions to access the power of an "apt" command, which can be gained temporarily by prefixing a command with "sudo."

It's good practice to update your list of installed software before you install a new piece of software, and you can do this by typing "sudo apt-get update." This command will check your list of installed software against what's available from the servers and update your list.

Once you've updated your software you can use "apt-get install ←packagename→," replacing "←packagename→" with the name of the software to install. To remove software, you can type "apt-get remove ←packagename→," followed by the name of the software. Apt is a powerful tool, so be careful.

The other, simpler method of installing software is through the dedicated Pi Store, but you'll need to download the client application before you can gain access. Visit http://store.raspberrypi.com/download. All of the apps are open source, and are created by thousands of eager coders and offer automatic updates.



Going Beyond Raspbian

Here's three more Raspberry Pi operating systems for you to try

by David Hayward

The Raspberry Pi is the very essence of creativity, freedom, and openness—everything the open source world stands for. It's little wonder that people like it so much. There's no end to the imaginative and creative uses for this fantastic little computer. We've seen Raspberry Pis reach the limits of the atmosphere, dive beneath the waves, and become an old-style arcade cabinet. A group of them has even teamed up to offer supercomputing capabilities. They've been encased in wood, cardboard, metal, plaster, and LEGO. Yes, LEGO. They've been used by engineering firms, schools, colleges, and universities. The only limit, it seems, is the imagination of those who wield one.

However, most of us have used our Raspberry Pis for a number of home-grown projects and to gain a better understanding of Linux, electronics, motorized robotics, networking, and programming—most of this has been thanks to the dedicated teams who have brought us the operating systems on which the Raspberry Pi runs.

The majority of RPi users will no doubt be using the official Raspbian OS—a Linux distro based on Debian—but there's more choice to experiment with. There is a wealth of Raspberry Pi-specific operating systems that enable users to get more from their Raspberry Pis in a specific area—be that media centers, retro gaming, or computing. We had a look at the tip of the Raspberry Pi operating systems iceberg to see which projects floated our imaginations.

The Raspberry Pi Media Center is probably the most used application. Thanks to its HDMI port, reasonable processing power, silence, and size, the Raspberry Pi has found a welcome place under many a television.

Users were initially fairly limited in what they could do, but there have since been many worthy advancements, thanks to the community of RPi users. We're guessing some of you reading this will have tried the XBMC OS version for the RPi, but how many of you have tried RasPlex, which is the Raspberry Pi-powered client for the Plex Media Server?

> “There is no end to the creative uses for this computer. The only limit, it seems, is the imagination of those who wield one.

Use your Raspberry Pi to turn your TV into a Smart TV, similar to Apple TV.

RasPLEX

Turn your Raspberry Pi into a media center

To begin with, you'll need to have an installed version of Plex Media Server, which is closed source but free to use. There are a number of Plex Media Server platforms to consider: OS X, Windows, Linux, NAS, and FreeBSD. There's even a selection of mobile operating systems that cater for Plex, so there's a pretty good chance you'll find a server platform to best suit your needs. If you get stuck with the server side of the installation, head to http://goo.gl/rld6P5 for a set of instructions.

GetRasplex - Offical Rasplex Installer
GetRasplex
Official graphical installer for the rasplex project.
Brought to you by Patrik and Dale.
Special thanks to Win32Diskimager project.
Please Donate! to support the project and future development :)
Step 1: Select Version
0.3.1
Step 2: Select Device to flash
Step 3: Download Image or select local image file
Refresh Device List
Update links
Download
Select image file
Downloads\rasplex-0.3.1.img.gz
Step 4: Flash selected device with selected image
Write SD card
Downloading image... please be patient.
8%
Cancel

The RasPlex Downloader makes it easier to get the operating system image onto the SD card.

When you've set up your server side and spent a few minutes organizing your media collection, plus checking the server side of Plex is picking everything up and pointing to the right locations, then you can start getting the RasPlex side of things going. First, make sure you have the following to hand: a Raspberry Pi (obviously), a 1GB or more SD card—class 10+ preferably—and access to your home network. You'll need to make sure the Raspberry Pi is hooked up to a monitor or television, and has a keyboard and mouse connected to it.

It's also worth mentioning at this point that although the first 256MB versions of the Raspberry Pi will run RasPlex reasonably well, it runs better on the newer 512MB versions for obvious reasons. RasPlex is still early in its development process, so while the team use and test with the 512MB version in mind, it is possible to do the same on the 256MB versions of the RPi—just don't expect it to operate quite as fluidly as its younger brother.

There are three installer types for RasPlex: Windows, OS X, and Linux. Download these from http://goo.gl/8LPXc9. They provide a simplistic graphical UI in which to download and transfer the image to your SD card. Just insert your SD card, execute the installer program and select the version of RasPlex to download (the current one is the one we'd recommend, unless you have something specific in mind). Then, select the downloaded image and click the "Write to SD card" button to commit the new OS to the card. Once the image has been transferred over to the SD card, simply insert it into the Raspberry Pi and power up the RPi for the RasPlex first boot.

The RasPlex first boot is where things start to happen, and as a result, the first time you boot into RasPlex the UI will be incredibly slow, almost non-moving if you're testing on the 256MB version of the RPi. This is normal, and is called a "cold cache." "RasPlex has a client-side cache of images, thumbnails, and metadata," says the FAQ on the RasPlex website. "On the first boot, the cache is 'cold,' and it takes a while to warm it up. If you notice that RasPlex is running slowly on first boot, you can force warm-up the cache."

To speed things up for future sessions, you can force a "warm cache" by entering the "All" section and loading up the "All Videos," "All TV Shows," and so on until every thumbnail and fanart image has been loaded, therefore forcing RasPlex to cache everything. Naturally, you don't necessarily have to do this, but the responsiveness of RasPlex afterwards makes up for the time taken to cache everything.

Lend a helping hand

As stated, RasPlex is merely starting off on the RPi, so why not help make it better. Visit http://goo.gl/lvIsUC for some great methods on how best to keep the project alive and continually improving. In the meantime, though, enjoy those HD movies on your RPi.

XBian

RasPlex is built on XBMC, but many people prefer the original to anything spawning from it. Therefore, XBian offers the minimal Raspbian image, together with XBMC, for a complete, bleeding-edge solution. It's very impressive and comes with a vast community to rely on if you get stuck at any point. Drop by www.xbian.org and follow the various links to download and experience XBMC on the Raspberry Pi.

There is a number of benefits to using XBian over RasPlex. For starters, you won't need the server side of Plex, just a suitable NAS drive, media server, or simply your media on a USB drive. Secondly, XBian is low on system resources, and there's out-of-the-box support for a lot of wireless network adapters. Thirdly, the UI is very smooth—since XBian is so lightweight it fits neatly on a 2GB SD card, and the playback of media is generally very good.

In the end, personal preference usually wins through, but it's always best to test both systems to see which suits your home setup.

RISC OS

Take a trip down memory lane and use your RPi to join the Elite

RISC OS is functional, fast, and retro, all at the same time.

Retro is definitely in vogue. You can't switch on the TV, open a newspaper, or browse the web without something awesome from your computing youth appearing before your eyes. It's quite magical really, and what could possibly be more retro than the excellent *Elite*?

Elite was pretty amazing, as far as games go; and when played on the original systems, be it Spectrum, Commodore, BBC, or whatever, it's enough to bring a nostalgic tear to a glass eye. Anyway, before we get lumps in our throats, we thought it would be fun to get *Elite* working on an RPi with Acorn's RISC OS installed—a kind of smorgasbord of retro heaven. Sniff.

The NutPi bundle

RISC OS was originally released in 1987, named Arthur 1.20 as it was back then, and developed by Acorn Computers for its ARM-based Archimedes machines. This version for the Raspberry Pi is, of course, free, but you can purchase a software bundle, called NutPi, for $60. It contains many extras and enough programs to make RISC OS RPi a fully usable and viable everyday machine.

Within the default collection of programs for the RPi version of RISC OS, you'll find a web browser, text editor, and even BBC BASIC. So if you get bored with *Elite*, you can always program your own game. The first item on the agenda is to download the latest version of RISC OS for the RPi. It's not difficult, all you need to do is nip on over to the RPi website (www.raspberrypi.org), then click on the "Downloads" section and scroll down until you see the "RISC OS" section. You will then have the option to download the image via a torrent, or directly. It's only 97.9MB, so shouldn't take too long to snag from the ether. Once you have successfully downloaded the image, unzip it and use either the Win32DiskImager for Windows, the RPi-sd card builder utility for Mac OS X, or the "dd" command for Linux users, depending on your system and personal preference.

Upon booting, you'll notice that RISC OS is a nice-looking operating system, especially if you have a decent 1080p monitor hooked up to the Raspberry Pi, as RISC OS takes the full screen to display all its glory. Unfortunately, you won't be able to use the network aspects of the RPi to start with, as it has been disabled by default. But it's easily remedied. Start by closing the error message from NetSurf, then double-click on the "!Configure" icon on the desktop. Then, single-click the "Network" icon, followed by the "Internet" icon. Select the "Enable TCP/IP protocol suite" tick box and the three icons within should light up. Now, click on the "Close" button, followed by "Save" from the previous window, and reboot with "Reset Now."

Elite and Emulators

Because *Elite* was written for ARM2- and ARM3-based computers, it won't run under the ARM6 environment of the Raspberry Pi. So we need to emulate an older version of RISC and ARM by using ArcEm.

It is possible to download the emulator and its corresponding ROMS individually, but there is an easier way. We can download a single compressed file that contains all we need to get Elite emulated. However, if you try to open the "!ArcEm" file, it opens up StrongArm instead. Luckily, you can enjoy *Elite* by following these instructions: visit http://arcem.sourceforge.net and download the relevant file, then unpack the contents onto a USB stick. RISC OS doesn't necessarily require you to install a program, it will load the program from the external device.

Insert the USB stick into the Raspberry Pi and wait until RISC OS picks up the new device. Now left-click to open up the file manager, then, using NetSurf, navigate to http://goo.gl/6Tl0E and download the latest ArcEm file. This is a compressed file, but we need to open it via a RISC OS application called "!sparkFS." Single-click on the SD card icon in the bottom-left of the screen to open the contents of the filesystem, then double-click the "Utilities" folder. Locate the program "!sparkFS" and double-click—it should now appear next to the set of icons in the bottom-left. Drag the newly downloaded "arcem-1.50-alpha2-riscos" file onto the "!sparkFS" icon that's in the lower left. This will bring up a window of contents, which should be dragged and dropped over the original contents of the ArcEm file. This will replace the "!ArcEm" file and the "hostFS" folder, as well as a text file, with ones that will work in this instance.

It's like we're back in 1984.

Now navigate to http://goo.gl/wEGK2, and download the "b5052410.arc" file. As before, drag it onto the "!sparkFS" icon then drag the uncompressed contents into the "hostFS" folder. To get *Elite* running, double-click the new "!ArcEm" file, which will load up the old Archimedes platform, then double-click the "HostFS" drive. This should launch *Elite*, but sometimes we needed to double-click the icon "!elite." You'll be asked if you have a hi-res screen, to which you can say "Y." *Elite* should take about 10 seconds to load.

RetroPie

Turn your RPi into a classic gaming console

Doomguy in your palm? Let's hope he's not got the chainsaw.

While we're on the subject of gaming, and retro gaming in particular, what better use for your Raspberry Pi than as a retro gaming console? While retro gaming may not be for everyone, there is a charm to playing the likes of *Doom* on a computer you can fit in the palm of your hand—and besides, it's a great project to try out with the kids on those long, wet weekends.

RetroPie is an all-in-one operating system, which has been built from a much scaled-down version of Raspbian, with a few extras thrown in for good measure. It was conceived and created by Raspberry Pi and retro enthusiast petRockBlock, who has painstakingly taken a significant amount of time maintaining and updating the RetroPie project for our benefit. Yay.

To start, navigate to http://goo.gl/34tFaI and download the latest, zipped version of the RetroPie OS img file. Then, uncompress it and transfer it to a 4GB SD card via the usual methods, as detailed on the Raspberry Pi site.

Once that's all done, hook up your Raspberry Pi to a suitable monitor or television, add a keyboard, a mouse, and a USB gamepad for that added gaming experience, and then power-up the Raspberry Pi.

The first boot will go through the setting up of a controller used to navigate the EmulationStation UI, which is essentially the menu screen, where you can choose the various emulators and games to run and play. Be warned, however, that as with most first boot operating systems on the Raspberry Pi, the process can be very slow. After that, though, things speed up and you'll be playing away on all your retro games as normal.

After the setup is finally complete, you'll be placed back at the Terminal, or command line, so simply enter "emulationstation" to load up the RetroPie UI.

ROMs and controllers

The games you start with are fairly limited shareware versions of *Duke Nukem 3D* and *Doom*, as well as a bizarre Apple II game no one has ever heard of, so you'll most likely need a few more. But, therein lies some questionable legality regarding the downloading and playing of gaming ROMs. Some are perfectly legal, others aren't. So rather than get into a legal gray area we can't possibly defend ourselves against, it's probably best if we leave you to your own devices where ROMs are concerned. We're fairly sure you know your way around Google well enough to figure out what to do next.

Also, check out http://goo.gl/QFMWCw for the interesting RetroPie GPIO adapter pages on the petRockBlock website. These offer a comprehensive step-by-step guide on how to create a device that allows a variety of game controllers to be connected to your Raspberry Pi. Media, retro gaming and an excellent alternative full operating system are just the icing on the cake where the Raspberry Pi is concerned. There are plenty more full, specific operating systems available for you to try out and experiment with.

Now you've played around with the RPi, how about making your own operating system? In fact, why not drop us a line and let us know about it? Get in touch and tell us how and why you designed your own Raspberry Pi operating system.

> Now you've played with the RPi, how about making your own OS?

RetroPie Supported Systems and Emulators

As per the petRockBlock site, the list of supported emulators and systems from version 1.9 of RetroPie is pretty impressive:

- Amiga (UAE4All)
- Apple II (Basilisk II)
- Arcade (PiFBA, Mame4All-RPi)
- Atari 800
- Atari 2600 (RetroArch)
- Atari ST/STE/TT/Falcon
- C64 (VICE)
- CaveStory (NXEngine)
- Doom (RetroArch)
- Duke Nukem 3D
- Final Burn Alpha (RetroArch)
- Game Boy Advance (gpSP)
- Game Boy Color (RetroArch)
- Game Gear (Osmose)
- Intellivision (RetroArch)
- MAME (AdvMAME)
- MAME (RetroArch)
- N64 (Mupen64Plus-RPi)
- NeoGeo (Genesis-GX, RetroArch)
- NeoGeo (GnGeo)
- Nintendo Entertainment System NES (RetroArch)
- PC Engine/TurboGrafx 16 (RetroArch)
- PC/x86 (rpix86)
- PlayStation 1 (RetroArch)
- ScummVM
- Sega Master System (Osmose)
- Sega Megadrive/Genesis (DGEN, Picodrive)
- Sinclair ZX Spectrum (Fuse)
- SNES Super Nintendo Entertainment System (RetroArch, PiSNES, SNES-Rpi)
- Z Machine emulator (Frotz)

If you can't find what you want in there, why not incorporate one yourself, and let the open source community know about it?

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Oculus Rift DK2

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

BACKGROUND:

A new paradigm in PC gaming? Yet another false dawn for virtual reality? Or nothing more than a tool to accelerate Facebook's social media hegemony? Just what to make of the Oculus Rift? Torn asunder here in heavily revised Development Kit 2 format, one thing is for sure—the device is fast approaching retail status.

MAJOR TECH SPECS:

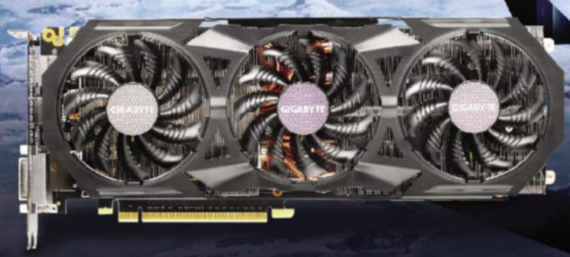
- Low-persistence 5.7-inch Super AMOLED display with a resolution of 960x1080 per eye
- Accelerometer, gyroscope, and magnetometer with an update rate of 1000Hz
- Positional tracking via external camera with near-infrared CMOS sensor
- Built-in latency tester
- 100 degree field of view (a significant upgrade from DK1)

KEY FINDINGS:

- Oculus Rift Development Kit 2 shows some noticeable streamlining in size and shape. Opening the treasure chest, we get a glimpse of a single motherboard, not the tiny multiple boards of the original Oculus Rift, eliminating the need for an external control box.
- The main display has a rubber case housed in a plastic backing. Inside the rubber casing is—drumroll please—the full front panel of a Samsung Galaxy Note 3 smartphone featuring a 5.7-inch Super AMOLED 1080p screen. Even the Synaptics S5050A touchscreen controller is intact.
- Oculus claims the DK2 display is a low-persistence OLED screen capable of a 75Hz refresh rate. This means Oculus is overclocking the Note 3 display panel from its stock 60Hz, allowing smoother motion.
- The DK2 includes a new positional tracking unit. It's an external IR camera specially designed to work with the new Development Kit. You can't substitute an old webcam, nor retrofit the tracking to DK1.
- Within the faceplate, we find two new and improved lenses, which have increased in size to accommodate a wider IPD (interpupillary distance) range. For those gamers who sport geek-chic glasses, the Oculus team has included different eyecups of varying focal lengths, just like it did in the Oculus VR, though this isn't a perfect solution.
- Repairability Score: 9 out of 10 (10 is easiest to repair). Standard Phillips screws are used in both the headset and positional tracker, making them a cinch to open. Cable management is much improved, and the elimination of the control box makes for a simpler, more streamlined device. The use of a common smartphone display means replacement parts are readily available. Given that the Rift is still a beta product, this is still a preliminary score—but things are looking good.

GIGABYTE™

600 WATT OUT



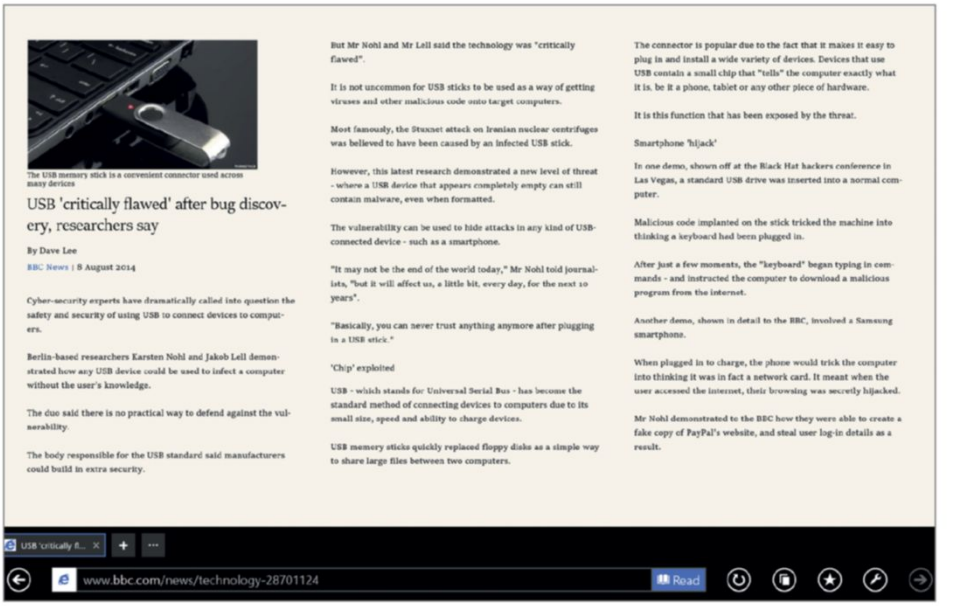
WINDFORCE

World's Best 600W Air Cooling System

HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH


The USB memory stick is a convenient connector used across many devices
USB 'critically flawed' after bug discovery, researchers say
By Dave Lee
BBC News | 8 August 2014
Cyber-security experts have dramatically called into question the safety and security of using USB to connect devices to computers.
Berlin-based researchers Karsten Nohl and Jakob Lell demonstrated how any USB device could be used to infect a computer without the user's knowledge.
The duo said there is no practical way to defend against the vulnerability.
The body responsible for the USB standard said manufacturers could build in extra security.
But Mr Nohl and Mr Lell said the technology was "critically flawed".
It is not uncommon for USB sticks to be used as a way of getting viruses and other malicious code onto target computers.
Most famously, the Stuxnet attack on Iranian nuclear centrifuges was believed to have been caused by an infected USB stick.
However, this latest research demonstrated a new level of threat - where a USB device that appears completely empty can still contain malware, even when formatted.
The vulnerability can be used to hide attacks in any kind of USB-connected device - such as a smartphone.
"It may not be the end of the world today," Mr Nohl told journalists, "but it will affect us, a little bit, every day, for the next 10 years".
"Basically, you can never trust anything anymore after plugging in a USB stick."
'Chip' exploited
USB - which stands for Universal Serial Bus - has become the standard method of connecting devices to computers due to its small size, speed and ability to charge devices.
USB memory sticks quickly replaced floppy disks as a simple way to share large files between two computers.
The connector is popular due to the fact that it makes it easy to plug in and install a wide variety of devices. Devices that use USB contain a small chip that "tells" the computer exactly what it is, be it a phone, tablet or any other piece of hardware.
It is this function that has been exposed by the threat.
Smartphone 'hijack'
In one demo, shown off at the Black Hat hackers conference in Las Vegas, a standard USB drive was inserted into a normal computer.
Malicious code implanted on the stick tricked the machine into thinking a keyboard had been plugged in.
After just a few moments, the "keyboard" began typing in commands - and instructed the computer to download a malicious program from the internet.
Another demo, shown in detail to the BBC, involved a Samsung smartphone.
When plugged in to charge, the phone would trick the computer into thinking it was in fact a network card. It meant when the user accessed the internet, their browsing was secretly hijacked.
Mr Nohl demonstrated to the BBC how they were able to create a fake copy of PayPal's website, and steal user log-in details as a result.
USB 'critically fl...
www.bbc.com/news/technology-28701124
Read

MAKE WEBSITES EASIER ON YOUR EYES WITH READING MODE

One easily missed feature of Windows 8.1 is the new Reading Mode in Internet Explorer 11. Open Internet Explorer in Metro mode (only available if IE is your default browser) and navigate to the article you want to read. If that site has enabled Reading Mode, you'll see a small book icon to the right of the address bar. Click it for nicely formatted text with no ads.

MAKE – USE – CREATE

66
Troubleshoot POST problems

69
Make your gaming screenshots awesome

ALEX CASTLE
CONTRIBUTING EDITOR

ADD ANYTHING TO YOUR WINDOWS TASKBAR

The Windows 7/8 taskbar makes it easy to pin commonly used applications for quick access, but it doesn't directly support pinning folders or documents. If you try and drag these to the taskbar, they'll be saved as an item in a "jump list," which isn't quite as easy to get to. Fortunately, there's a way to get folders and documents directly onto your taskbar.

All you have to do is make a fake executable file, which you can do by creating a new text file (or any other file), and renaming it "temporary.exe." Windows will ask if you really want to change the extension, and when you say yes, the icon will change to represent an application. Drag this icon to the taskbar, then hold Shift, right-click on it and select Properties. Here you'll see a "Target" box. In File Explorer, find the folder or document you want to pin, Shift-right-click on it, and select "copy path." Paste this path into the target box, click "OK," and you'll be able to access your desired file with a single click.

↘ submit your How To project idea to: comments@maximumpc.com

Getting past the POST

YOU'LL NEED THIS

MOTHERBOARD MANUAL

POZIDRIV SCREWDRIVER
For any disassembly.

DANG, IT'S DEAD. You've pressed the power button and your PC's got little sign of life, let alone an operating system. You may have some text from the BIOS flash past, or a blue screen, or a blank screen. You may have complete silence or a flurry of beeping noises and frantic fans. Never mind driver problems, this is more fundamental than that. Your box has fallen at the first fence. The Power-On Self Test (POST) has bombed. Here's the *Maximum PC* guide to digging yourself out of the hole and getting your PC properly powered up. –CHRIS LLOYD

1 ARE YOU ALL PLUGGED IN?

Keep it simple and start with the basics. Never underestimate how easy it is to make a fundamental error.

» Is it really on? On the back of your PSU there is probably an innocuous-looking black rocker switch (**Image A**). This turns it on. Often never touched in everyday use, it's possible to forget about it and start messing with the panel switches and worrying about dead components when all the time you haven't switched on the juice, especially on an unfamiliar PSU. If this still fails, try replacing the power cable—you may have a faulty one—even if that's fairly unlikely.

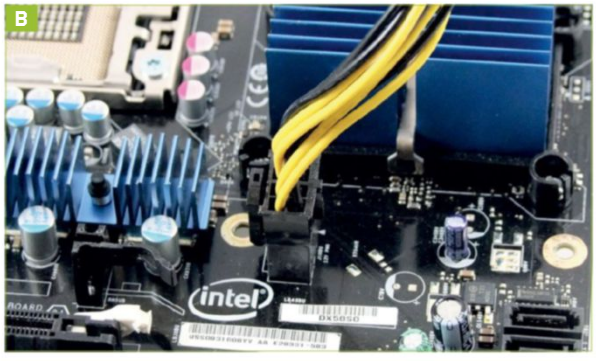
» Next check the processor power (**Image B**). Chips get their own power supply, and it's ridiculously easy to forget to plug this bit in, which leads to a seemingly dead system. It'll use either an 8-pin block or a 4-pin block. Often the power supply lead splits the 8-pin into two 4-pins to be compatible with both. It's the socket right next to your processor, often labelled "12v ATX." If in doubt then it's in the manual (which you've read, haven't you?). Another easy miss is the power for your CPU cooler. Some boards refuse to do anything unless they detect this plugged in.

» Now for video power. Nothing on the monitor? Another easily overlooked connection is the graphics card's power supply. They can be hungry things, and only the gutless kind can run off the socket power alone, a mere 75W maximum. The exact requirements depend on the beefiness of the card. There are either one or two 6-pin blocks and/or an 8-pin block. Just make sure they're all filled. It's best to use cables directly from the PSU rather than adapters. Check you've no loose wires in the blocks, and don't force it, they only go in one way (**Image C**).

» Finally, give the front panel switches a once over. They're fiddly little cables that are easily missed. The polarity of the reset and power switches isn't important. If your activity lights fail to light, try reversing the connection. Disconnect the reset switch if you suspect a short (either not booting, or endless booting). You can also fire a system manually by shorting the power pins with a small metallic object if you suspect your case switch, but make sure you've properly identified them.

A

B



C

2 OK, SO IT'S ALL PLUGGED IN. WHAT'S NEXT?

A poorly seated video card is a common error. The cards can take considerable force to get them properly seated, more than a novice builder may be expecting (**Image D**). This can be worrying, as flexing your board is really not a good idea. Make sure the board is fully supported with stand-off posts before applying pressure. Many boards have securing clips for the card—if you can't get these to click into place neatly, then the card needs pushing down further. Try removing and re-seating if the angle is at all crooked. Be firm and gentle at the same time (yes, we know this is impossible, but you know what we mean).

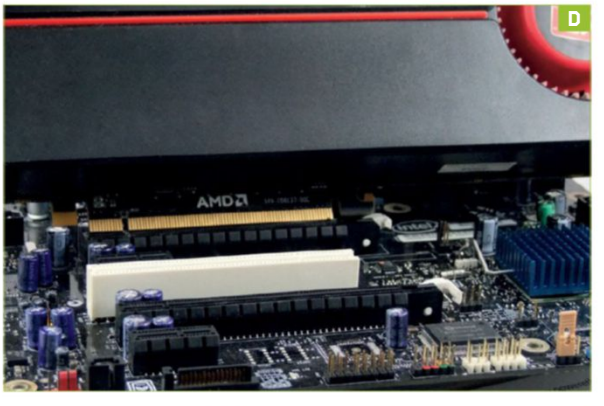
» Another potential issue could be unwanted shorts. If an electrical conductor touches your board then it can cause a short circuit on the fine network of tracks, which is guaranteed to cause trouble. Check the small posts that the board sits on. Did you install them all in the correct places? There is no standard pattern, meaning it's easy to get one of them in the wrong place, especially as you won't see it from the top either. A misplaced one can easily cause a short circuit on exposed soldering (**Image E**).

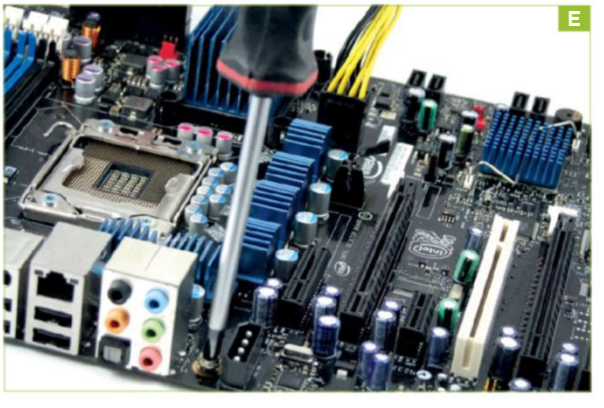
» Did you drop a screw in there? It's easily done (Image F). Retrieve everything you drop straight away in case you forget. Are there any wires touching the board which may have worn insulation? It's good practice to have all wires routed well away from the board, especially underneath, which has sharp soldered connections that can cut into wires. Many cases have a tray under the board to keep wires out of such trouble.

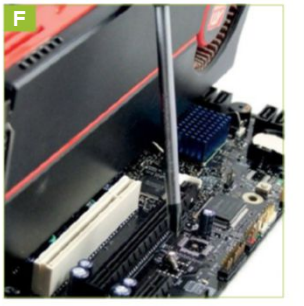
» It's worth checking your memory modules are all fully seated, with the securing clips in place (Image G). This can take more force than you might expect. Are they in the right slots? Some boards want the slots used in a strict order, others aren't fussy. Check the manual to make sure you've filled them in the right order as wrongly configured RAM is a common cause of dead boxes. It must match the board and processor. Try booting with a single stick of RAM, or one pair for coupled systems. You may have either a faulty RAM socket, or stick, so mix it about to pin it down.

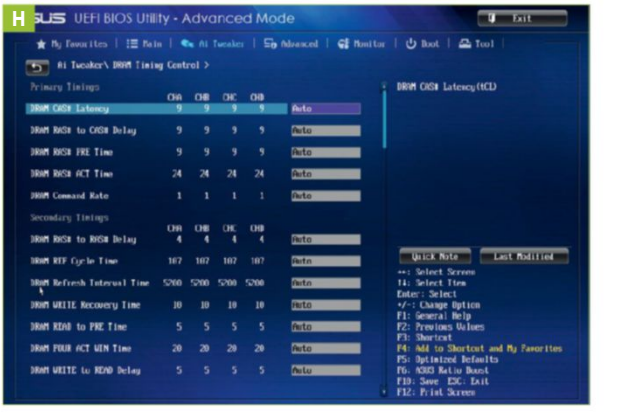
» Potentially, the issue is with the memory speed. If it can boot with at least one stick of RAM, then enable the XMP (Extreme Memory Profile, basically factory-approved overclocking) in the BIOS if the board supports it, or manually set memory speeds in the BIOS to match your stick's specs. If you have sticks rated at a higher voltage than the default settings allow, it can cause stability problems. On some boards, leaving it on "Auto" won't supply enough juice (Image H) .

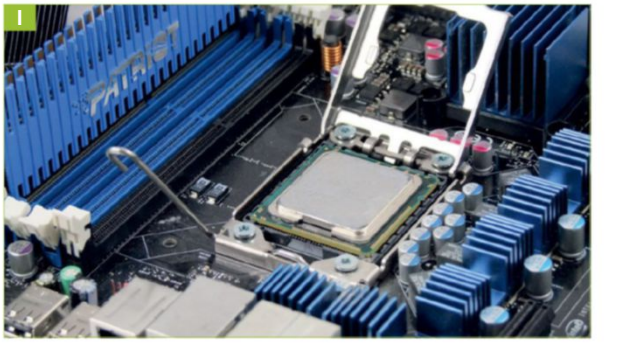
» Now check your processor is seated cleanly, flat, and the right way around (Image I). These days it's hard to get the processor in the wrong way around—it's physically impossible for most. There's a visual indicator on the chip (a little arrow or similar). The socket will have the same indicator, or will be obviously not symmetrical. This is one bit of hardware where undue force should never be used as we don't want a bent pin or a borked socket. Pins can be coaxed back to vertical, very, very carefully. But if it breaks, you're stuffed.











3 YOU'VE COVERED THE OBVIOUS BASES, NOW WHAT?

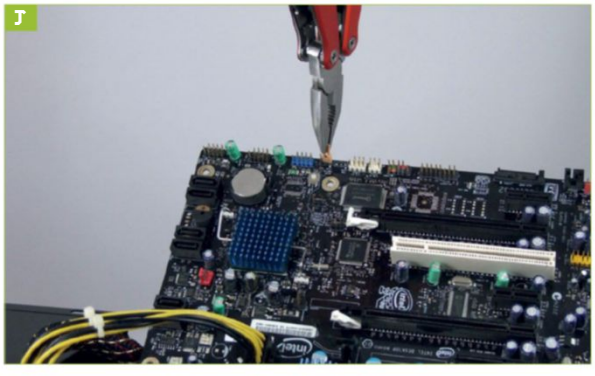
Your processor cooler can look OK to the eye, but it needs to be firmly in place and completely flush, otherwise the processor will overheat in very short order. Are all of the connectors snug and the cooler level? Did you put a (tiny) bit of thermal paste on? The surface between the top of the chip and your cooler needs to be good and true—sorry, but there's no "that looks good enough" here. The motherboard's thermal cut-out will trigger if it detects the temperature going through the roof. This may only take seconds.

» Clearing the BIOS is not to be considered too early as it will wipe useful information. But resetting the CMOS can fix some settings woes. The simple way is to go into the BIOS and restore the factory settings. The exact wording varies, "Clear BIOS," "Reset to Default," or similar. Not a lot of help on a system that's dead before you can get into the BIOS setup. Most boards have a jumper or DIP switch that will reset the CMOS (see that manual). Once cleared, your BIOS will re-detect all your hardware on booting, which may clear an overlooked incompatibility (Image J).

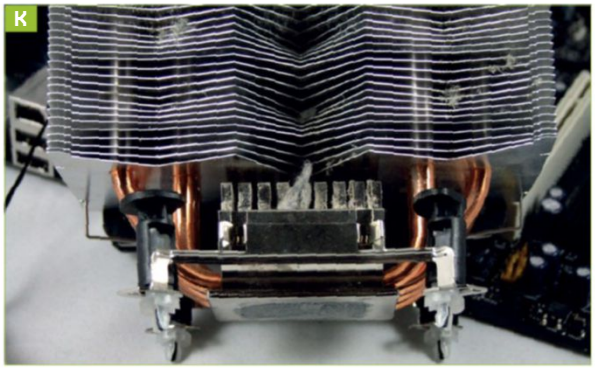
» Does everything appear to fire but the chip fan goes mental and then the whole system locks up? It could be processor cooling. Assuming your cooler is fitted properly, next suspect a restricted airflow, hence the fan running on maximum. Often it's an accumulation of dust deep inside the cooler, sitting between the fan and lodged in the cooling fins (Image K). Or you may have hair wrapped around the fan itself, causing it to struggle. A fine pair of tweezers or a more thorough disassembly will put things right. If your rig sits on the floor and gets heavy use, this could be a reoccurring and common woe.

» If you've a board with layers of dust and grime, you may have collected dielectric material, or the scum may be acting as a blanket of insulation (Image L). Blowing is best, using your mouth, an air duster, or hairdryer (not too hot). Use a soft brush on more stubborn bits. If it's really grubby, you have the death or glory option of washing it in water (yes, really). Remove any CMOS battery and dip into the wet stuff (some espouse special solvents, but clean water leaves very little residue). Be very gentle and leave to dry, days not hours (a gentle blow-dry will help). Obviously it must be totally dry before running any power. If it works, glory. If not, tough—it's totally dead now.

J



K



L

BEEPING BEEPS

If your box is beeping, it's trying to tell you something. To hear these tones you used to need a system speaker. Unlike your regular sound system, a system speaker is separate and specifically for error codes, but we haven't seen one of those for years, as boards now have their own beep-maker.

IBM set out the original set of beep codes. One long beep and two short, for example, means it can't find a working graphics card. BIOS makers have since added more error codes, but there's no standard for what each one means. There are some consistencies (small numbers of short beeps are mostly memory errors), but there are also enough inconsistencies for it to annoyingly require specific documentation.

If your system beeps, however, it means we have a clue, and to the manual we go, or a working Internet connection (search for "POST error codes"—the top articles are all fairly good, especially the TechNick one). Once you've located the source, remove and re-seat the offending hardware and try again. If it's a powered component, check the power is plugged in. Possibly try a different power cable. Try swapping things around as described in the main text if it's a memory error.

While the error codes are a decent pointer, they give no idea as to the exact problem—it may be a seating problem or it may be trashed. But they're a huge help.

Make your gaming screenshots awesome

YOU'LL NEED THIS

GIMP
The free, yet powerful, GNU Image Manipulation Program.

WE'VE ALL EXCITEDLY GRABBED A SCREENSHOT of that cool moment in a game, only to discover the colors are washed-out, it's off-center, and generally looks rubbish. This means the screenshot either languishes forever on you computer, never to be seen, or you post it and it's ignored because it just doesn't look exciting. Thankfully, there are plenty of techniques to turn screenshots from almost any game (yup, even this month's cover-feature muse, ***Minecraft***) into something to be proud of, an image to blog about, post onto Steam community pages, or just enjoy at home. –**ALAN DEXTER**

1 PREPARE YOUR PC

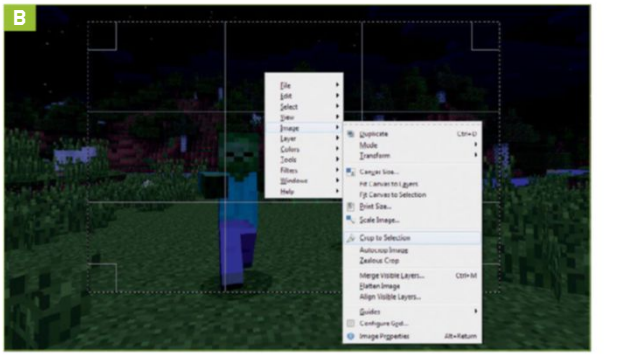
Before taking your shot (**Image A**), tinker with your visual settings so they're as high as possible. Max out your resolution, too. Also, head to www.gimp.org and install the GNU Image Manipulation Program (GIMP). There are plenty of good and free image editing packages out there, but GIMP packs an incredible amount of power, so it's our choice.

A

2 CROP TO THE ACTION

First, you need to frame the subject. For starters, when taking the screenshot, aim to hide the game's interface, unless it's relevant. Next, use GIMP to apply the classic "rule of thirds" photography technique. Click the "Selection" tool (top-left) and select "Rule of thirds" from the "Guides" drop-down. Drag a box over the most eye-catching area, right-click it, and select "Crop to selection" from the "Image" menu (**Image B**).

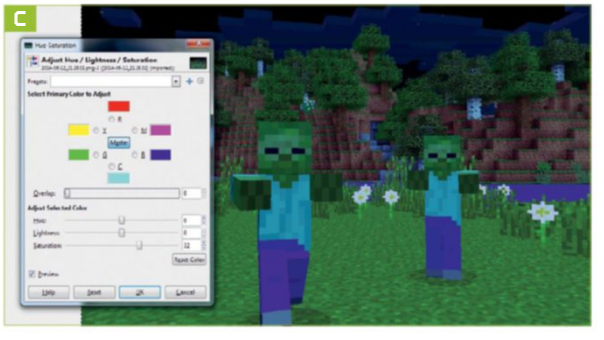
B



3 PLAY WITH THE COLORS

Many screenshots are too dark. To lighten, select "Levels" from the "Colors" menu and drag the arrow under the right-hand side of the graph to the left. Next, deal with the often moody restricted palette in games. Select "Color balance" from "Colors" and use the sliders to make the tones more natural. Lastly, up the saturation to make the colors pop out. Saturation controls are also under "Colors" (**Image C**). Try increasing the saturation by 20-40 percent. Going too far can give a cartoony feel, but careful use can make your images more vibrant.

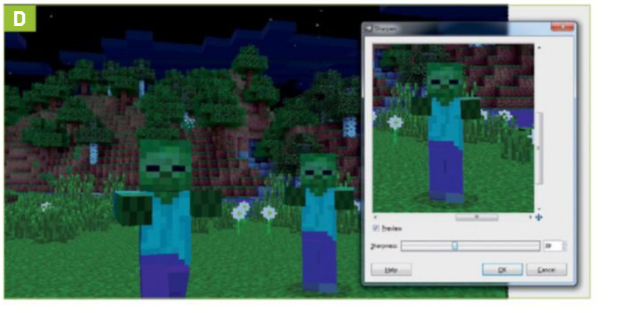
C



4 THE FINAL POLISH

Now, sharpen up your image to add more impact. Select the "Filters" menu, expand the "Enhance" section and click "Sharpen" (**Image D**). Again, something in the order of 20-40 percent should be enough. If it's more your style, use the "Gaussian blur" tool from the "Blur" section. Another option is to add lens flare for extra shine. But don't overdo it, unless you want to be the next J.J. Abrams. All that's left is to resize your image and save it in a format that works best, usually JPGs.

D



BUILD IT

ALAINA YEE **CONTRIBUTING EDITOR**

Overclocking in a Budget Gaming PC

LENGTH OF TIME: **2–4 HOURS** | LEVEL OF DIFFICULTY: **MEDIUM**

Intel's new Pentium K CPU comes with both a bargain price and bargain specs—so we put it to the test in a budget gaming system

THE MISSION

AS OUR MONTHLY BLUEPRINT roundup demonstrates, putting together a budget gaming system for under $800 is very doable. It just comes with trade-offs—one of which is giving up on CPU overclocking. Unlocked Intel Core i5 chips start at $100 more than the AMD FX-6300 part in our budget Blueprint build, and in a rig where even going up or down by $20 becomes noticeable, that extra cost is beyond justification.

But this summer, Intel released the Pentium G3258—or as we like to call it, the Pentium K. At $70, this unlocked 3.2GHz dual-core Haswell chip looks pretty attractive on paper. It undercuts the AMD FX-6300 by $40 and the cheapest Core i3 CPU by about $50, making it economically feasible as an alternative CPU... so long as the ability to overclock gives it a big enough boost to shore up its budget architecture. There's only one way to find out if it's worth it in order to chase the dream of overclocking in a budget build, so we put together a rig with the Pentium K as the star of the show.

CLEANING UP NICE

AS THIS IS A BUDGET SYSTEM, we weren't ultra-picky in parts selection. We made some compromises, such as the case, deciding to show last issue's Enermax Coenus some love. Despite its seemingly *Transformers*-themed appearance, the Coenus is spacious and has a thoughtful layout that accommodates many random part swaps. It also looks much more attractive than a cutthroat-cheap Rosewill case. Likewise, we stuck with modest but reliable parts for our RAM and PSU: two sticks of 4GB Corsair Value RAM to run in dual-channel mode, and the Corsair CX500 to take advantage of its 80-Plus Bronze rating, ample cables, and three-year warranty.

We spent a little more on parts that future-proofed us (the Z97 mobo), affected overclocking (the H60 CLC CPU cooler), or improved our gaming experience (the larger-than-bare-minimum SSD). We felt our spending was warranted, given we wanted to push our Pentium K as high as it could go and also go for better gaming.

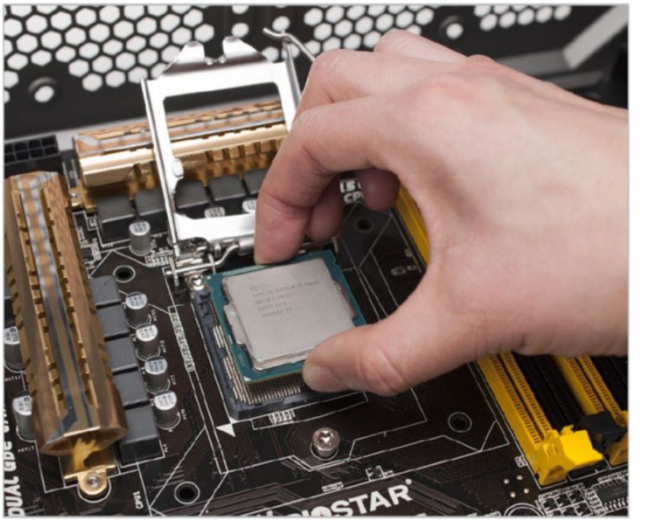
The only part we struggled with was the GPU. Our rig could handle a beefy and elaborate setup, but we chose to spend conservatively, which resulted in ignoring our mobo's Crossfire-only compatibility and going with a GeForce GTX 750 Ti card from EVGA.

INGREDIENTS

	PART	PRICE
Case	Enermax Coenus	$55
CPU	Pentium G3258	$70
CPU Cooler	Corsair H60	$55
Motherboard	Biostar Z97WE	$125
RAM	2x 4GB Corsair Value	$82
GPU	EVGA GeForce 750 Ti	$160
PSU	Corsair CX500	$50
SSD	OCZ Vertex 460 240GB	$120
HDD	Seagate Barracuda 1TB 7200RPM	$62
ODD	Samsung SH-224	$20
OS	Windows 8.1 OEM	$100
Total		$899

1 DECISIONS, DECISIONS

PART OF THE REASON we chose the Coenus for our case (besides its cost) was the flexibility it gave us in determining the order of our build. For example, since the optical drive installs from the front, you can do that at any time. And pulling off the panel behind the motherboard gives access to cutouts, allowing you to install the CPU cooler's backplate after you mount the motherboard to the case, or install your hard drives at your leisure. We chose to install our motherboard first, and then followed with attaching the CPU's backplate to the board. We put in the processor next, taking care (as always) to drop it straight down into the socket while matching up the notches correctly.

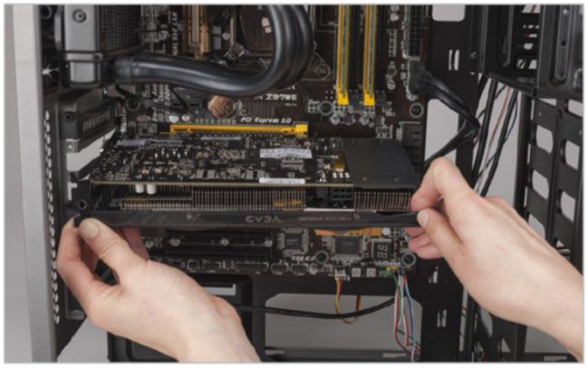


2 COOL RUNNING

WE FIRST TRIED installing the H60's fan and radiator at the top of the case, but changed tack due to the motherboard's awkward position relative to the top of the case and the length of the H60's tubes. Instead, we swapped them in for the Coenus's rear fan—a fiddly operation. We managed it by first holding the fan in place, then threading a screw through the fan's two top-right holes and lining up the radiator's corresponding hole with the tip of the screw, before beginning to screw the pieces together. (Note: Orient the tubes toward the bottom of the case to give you more room later.) We then repeated this process with the hole diagonal from the first screw, working in an "X" pattern, and by attaching the pump.

3 GUTSY MOVES

TO MAKE THE INSTALLATION of our CPU cooler easier, we waited to install our RAM until after we'd secured the cooler's pump. The thought behind what type of RAM we used was a little less studied—given the dependability of Corsair's value line, we grabbed two DIMMs of 4GB and popped them in. Settling on an EVGA GeForce GTX 750 Ti card, however, required more debate. We considered future-proofing by selecting a Radeon card, since this Biostar mobo supports only Crossfire dual-GPU configurations. But we settled on EVGA's 750 Ti, since in the real world few people use dual-card configurations at this price range, but well over half of gamers (on Steam, at least) prefer Nvidia. We inserted the video card now, so that after putting in the PSU we could hook up all the connectors at the same time.

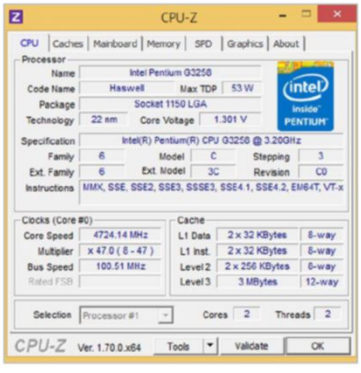


4 SHUTTING UP AND DRIVING

AS WE WANTED to plug in all of the power connectors at once, the optical, solid-state, and hard-disk drives went in next. Our Samsung SH-224 is a standard DVD/CD burner and nothing fancy; neither is our Seagate Barracuda 1TB HDD (the latter is for documents and media storage). By contrast, our OCZ Vertex 460 240GB SSD is almost double what we recommend for our Blueprint budget gaming build. As we noted earlier, the Vertex was a conscious splurge in order to get faster performance and more space to hold games, but it could be pared back to a 128GB SSD if you want to save $40–$50. The CX500 that feeds our budget rig doesn't take much space (the Coenus will easily hold larger), so popping it in was easy. If you're strapped for cash, opt for the CX430—but note it could limit your choice of future video cards.

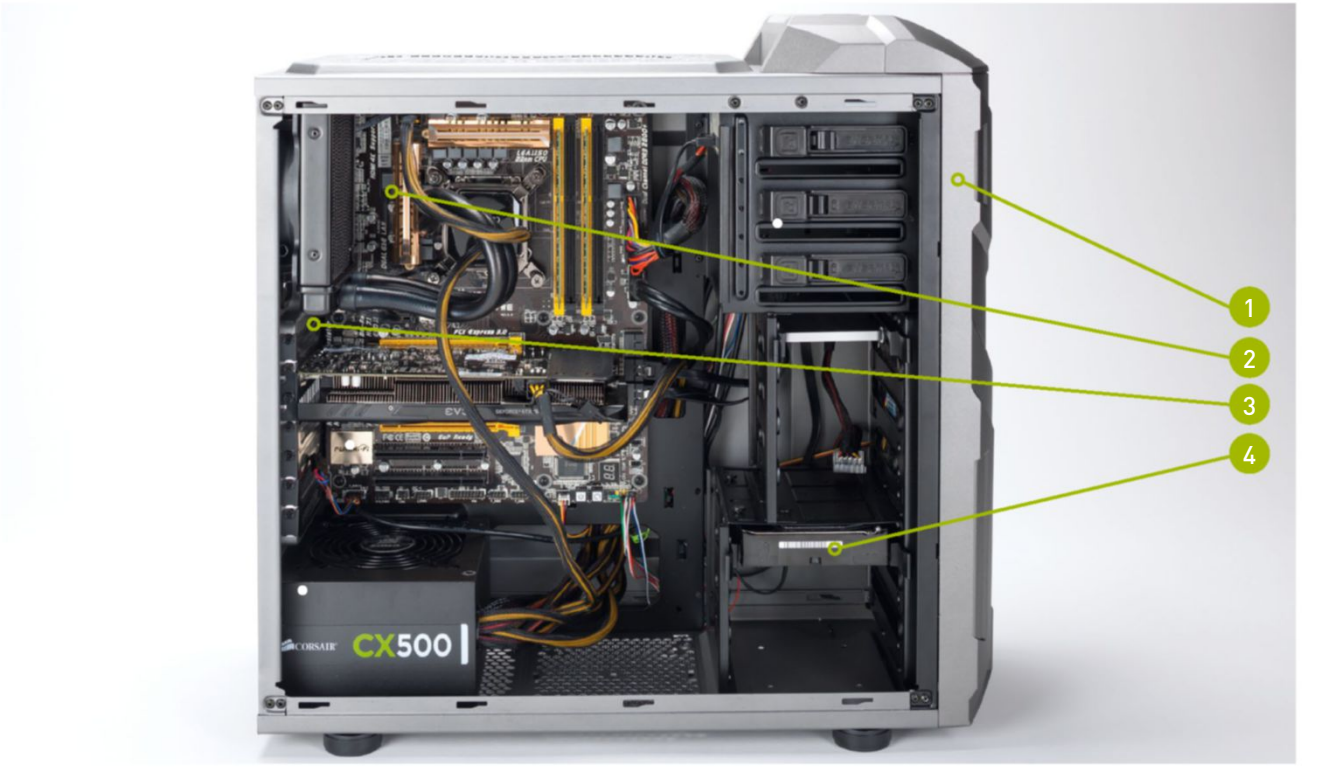
5 PREPARING FOR TAKE-OFF

AFTER INSTALLING WINDOWS 8.1, we first configured and ran all of our benchmarks under stock settings to set up a baseline for our comparison between the Pentium K's stock and overclocked performance. Then we prepared for our overclocking efforts by downloading CPU-Z and CPUID from www.cpuid.com/softwares.html, as well as Prime95 from www.mersenne.org/download and then installing all three tools. If you haven't used these programs before, CPU-Z provides clock information; CPUID lists the core temperatures; and Prime95 serves as the stress test for determining the stability of an overclock. Biostar also provides a Windows-based utility for overclocking, but we didn't have much luck with it. Even when installing the most recent version of the utility from the Biostar website, loading the utility caused our system to spontaneously reboot. Instead, we decided to stick to Biostar's esoteric but functional UEFI-BIOS interface for our overclocking tweaks.



6 ABSOLUTE POWER

TO OVERCLOCK the Pentium K, we worked in the "O.N.E." UEFI-BIOS submenu, found by clicking on the second-from-right icon at the bottom of the main BIOS screen. Increasing the amount of juice fed to the CPU had to be done via the "Voltages Configuration" option. First, we changed the "CPU Voltage Mode" to "Override," then we changed the "CPU Override Voltage Target" to 1.3V as our starting point (the CPU was automatically drawing just a little over 1.0V at stock speed). All the clock changes had to be tweaked via the "CPU Configuration" option. The first step was to switch the "CPU Ratio Mode" to "ALL cores," then we could up the clock speed via "CPU Ratio." We began with an overclocked speed of 4.0GHz and eventually got it to a stable 4.7GHz.



1. If you've got nimble fingers, you can pop out the faceplate for the optical drive slot without taking off the Coenus's front cover.

2. Our biggest beef with the Coenus for this build is the lack of openings near the 8-pin power port to neatly route the power cable.

3. Installing the CPU cooler's fan and radiator can be tricky. Thread the screw through the fan before lining up the radiator.

4. It may be budget, but at least adding storage is easy. Just slip two brackets on and slide the drive right into the cage.

SO HOW SPECIAL IS THE PENTIUM K?

AS THE FIRST OVERCLOCKABLE PENTIUM CPU, the G3258 doesn't disappoint. We built this rig to see how much power we could squeeze from this low-end chip, and the answer is quite a bit—after overclocking the Pentium K, we saw a sizable jump in performance in CPU-heavy tasks. It also beat CPUs with more cores. Not bad for $70.

Overclocking went butter-smooth, too. Our initial leap from 3.2GHz to 4.0GHz showed such a moderate jump in temperature that we went to 4.2GHz after just 15 minutes of stress testing. The K's temperatures held steady in the high 60s/low 70s in the 4.4GHz–4.6GHz range, and it wasn't until we tried to hit 4.8GHz that our system protested. Increasing the juice to 1.35V and then 1.4V didn't change our near-instant BSODs at 4.8GHz, and it wasn't until we stepped it down to 4.7GHz and dialed the voltage back to 1.3V that our rig happily chugged along in the low 70s. All in all, overclocking took us 10 minutes of troubleshooting; the bulk of our five hours spent on the task was letting Prime95 do its work. Our H60 definitely earned its keep.

The Pentium K also held up well. Our budget choice of video card impacted the benchmark results more than our choice of CPU. When we switched to a Radeon R9 280X, we saw notable improvement in two of our benchmarks. *Tomb Raider* shot up to 65.7fps, while *Metro: Last Light* rose to 56fps. Oddly, *Hitman: Absolution* dropped to 40fps, but our guess is that has something to do with the game not being well optimized for AMD graphics cards. Of course, benchmarks don't guarantee equal performance throughout games, but a K build should be a palatable budget gaming system. If you want to save cash for a better GPU, hunt for mail-in rebate deals on parts. We saw some available but excluded them from our price list. Had we done so, we'd have cut $50–$70 from the total price.

PERFORMANCE: STOCK VS. OVERCLOCKING

	STOCK	OVERCLOCKING
3DMark11 Extreme	1938	1965
Metro: Last Light (fps)	41.3	45.7
Tomb Raider (fps)	35.6	35.6
Hitman: Absolution (fps)	38.5	47.8
Stitch.Efx 2.0 (sec)	1,483	1,029
ProShow Producer 5.0 (sec)	2,008	1,427

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

All gaming benchmarks performed on maximum settings and with V-Sync turned off. For *Metro: Last Light*, SSAA and Advanced PhysX were left disabled.

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REVIEWS

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VELOCITY MICRO EDGE Z55
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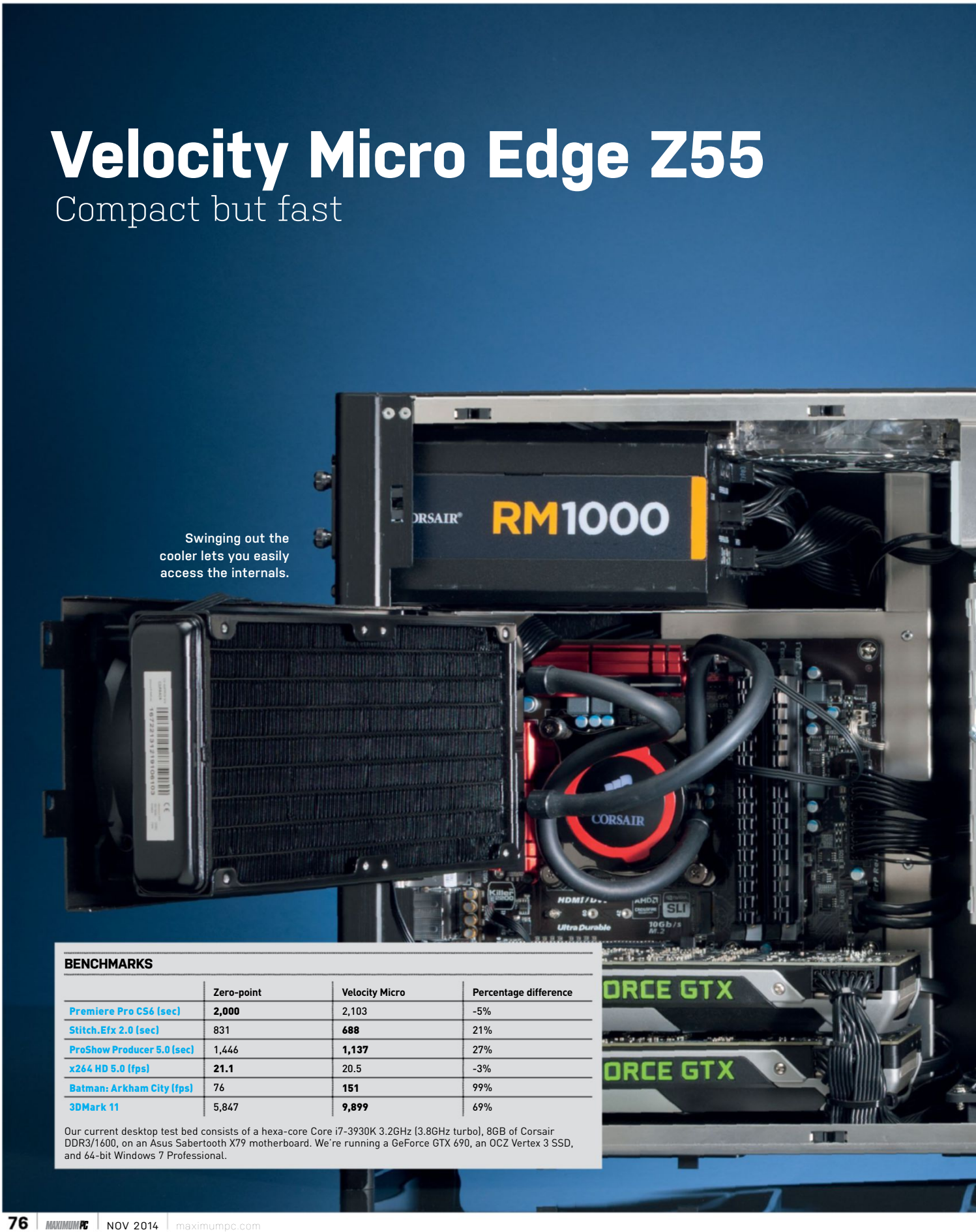
Velocity Micro Edge Z55

Compact but fast



Swinging out the cooler lets you easily access the internals.

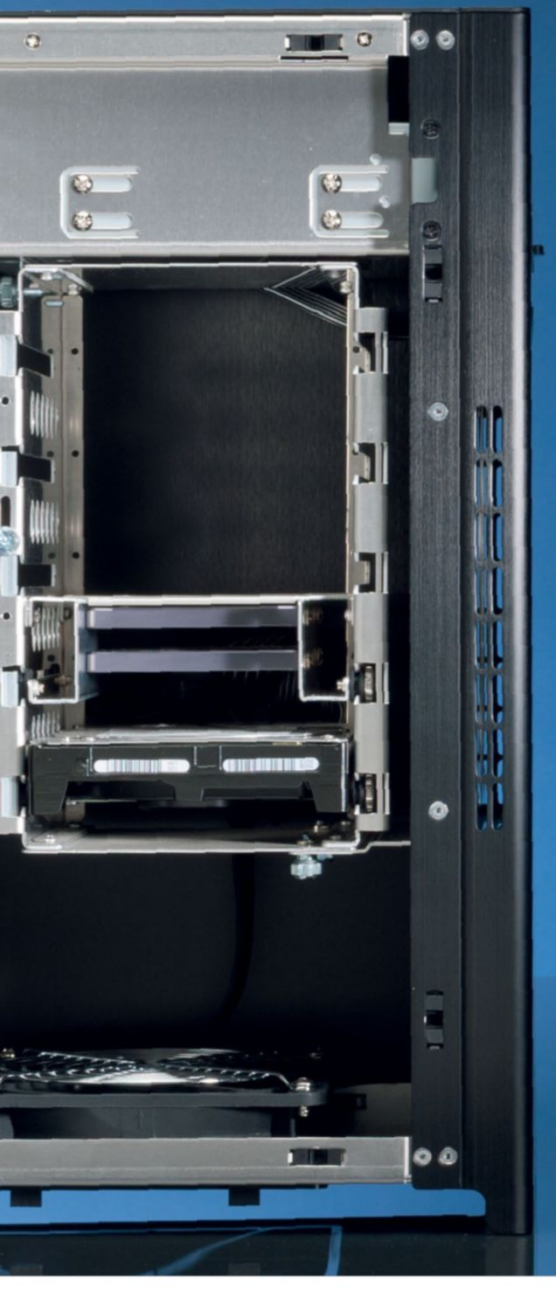
BENCHMARKS

	Zero-point	Velocity Micro	Percentage difference
Premiere Pro CS6 (sec)	**2,000**	2,103	-5%
Stitch.Efx 2.0 (sec)	831	**688**	21%
ProShow Producer 5.0 (sec)	1,446	**1,137**	27%
x264 HD 5.0 (fps)	**21.1**	20.5	-3%
Batman: Arkham City (fps)	76	**151**	99%
3DMark 11	5,847	**9,899**	69%

Our current desktop test bed consists of a hexa-core Core i7-3930K 3.2GHz (3.8GHz turbo), 8GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We're running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

IT'S NEVER GOOD TO WHIP OUT A NEW PC, plug it in, and click the power button, only to have absolutely nothing happen. Nada. Zilch. Zippo. The issue is only compounded when the problem box is a small MicroATX system packed with so much hardware that you can't even get your hand inside.

That's the problem we faced with the Velocity Micro Edge Z55. Like most review systems we get, it was expedited in shipping, which is a free license for the shipping firm's employees to dribble it down the tarmac like Shaq going for a slam dunk.



Fortunately, that's when we ran across one of the niftier features of the new MX3 case (a customized Lian Li case) that Velocity Micro uses: A swing-out tray for the liquid cooler. Remove two thumb screws and you can easily swing the Corsair 240mm radiator out of the way. Once we did that we did a quick re-seat of the machine's power connectors and we were up and running with no issues. It was almost so conveniently fixed that we wondered—with eyes squinting like Philip J. Fry—if Velocity Micro hadn't intentionally set it up that way just to show off how cool the case is.

On the inside, we found Intel's Core i7-4790K "Devil's Canyon" overclocked to 4.7GHz in a Gigabyte GA-Z97MX board with 16GB of Crucial Ballistix DDR3/1866. Storage duties go to a pair of 250GB Samsung Evo SSDs and a Tosh mechanical drive.

A pair of EVGA GeForce GTX 780 Ti cards in SLI handle graphics. The cards use the standard reference Nvidia coolers, which is one of our issues with the Edge Z55. The CPU is liquid-cooled by the Corsair closed-loop cooler, and even though heavily overclocked at 4.7GHz, the acoustics are extremely unobtrusive under a compute load. But crank up a gaming load for long enough, and the fan whir from the pair of 780 Ti cards lets you know this is no silent runner. What's odd is we've long thought Nvidia's reference design to be very decent considering the performance provided, but here it rains on the quiet performance of the PC under CPU loads. It's not horribly loud, but we've come to expect anything larger than a small form factor box to be extremely quiet.

THE BMW OF DESKTOPS?

The Maingear Epic Force, for example, which we reviewed in our October issue, packed four GeForce 780 Ti's in Quad SLI, but was silent thanks to its custom-liquid loop. That same machine, we should point out, cost nearly $13,000, making the Edge Z55's price tag of $4,300 seem damn near a bargain. It isn't, but at least the performance is good.

Our zero-point PC uses a six-core Core i7-3930K overclocked to 3.8GHz with a GeForce GTX 690 inside. The Edge Z55 surpasses it by more than 20 percent in our benchmarks that aren't thread-heavy. In Premiere Pro and x264 HD 5.0—both very multi-thread-heavy workloads—the Edge Z55 was slower by only about 3 to 5 percent. That's pretty good when you remember we're talking four cores versus six cores. In gaming, however, a pair of 780 Ti cards easily roughs up a GeForce GTX 690. We're talking about a 100 percent performance advantage in *Batman: Arkham City* and 69 percent in 3DMark 11 on the extreme setting.

But what about something more modern? The pricey Maingear Epic Force, with its CPU at basically the same clock, is just about even with the Edge, so score one for the system that's a hell of a lot cheaper. In gaming though, the Epic Force's four cards throat-punches the Edge's mere pair.

We're really looking at two kinds of computers, however, and two kinds of companies. Maingear is firmly in the boutique sector of PC building. It's the kind of company that, if you're a billionaire and want a gaming PC for your kid, you call up and drop $13,000 into a box like most of us put quarters in a parking meter. Velocity, meanwhile, sticks to its mantra that if companies such as Maingear or Falcon make Ferraris and Lamborghinis, VM makes BMWs. That kind of fits here. The Edge Z55 is a nicely adorned, pleasant-looking box, but it won't get you the same "oohs" and "aahs" as an exotic PC. It will, however, save you a serious chunk of change.

We'd prefer it if Velocity could tamp down the GPU noise, and even though it's a steal compared to a boutique box, it's still on the pricey side. Otherwise, it's a solid all-round effort. **–GORDON MAH UNG**

VERDICT **8**

Velocity Micro Edge Z55

+ SPEED Relatively fast; compact.

– SPEED 2 Relatively expensive; GPUs noisy under load.

$4,299; www.velocitymicro.com

SPECIFICATIONS

Processor	Intel 4GHz Core i7-4790K
Mobo	Gigabyte GA-Z97MX
RAM	16GB Crucial Ballistix DDR3/1866
Graphics	2x EVGA GeForce GTX 780 Ti
Storage	2x 250GB Samsung EVO SSDs in RAID 0; 1x Toshiba 3TB HDD
Optical Drive	Asus Blu-combo
Case/PSU	Velocity Micro MX3 / Corsair RM1000

Nvidia Shield Tablet

The best gaming tablet in town

The Shield's Nvidia Tegra K1 SOC is smoking fast.

WEIRDLY BULKY BUT SOMETIMES BRILLIANT, we actually liked Nvidia's original Shield Android gaming handheld. So, with rumors swirling around a slimmer, lighter Shield 2, consider us initially disappointed by what looks like yet another Android tablet. Yawn, right? Nope. Shield Tablet is great at what it sets out to do.

At eight inches, the Shield Tablet features a gorgeous 1920x1200 display, the same resolution as Google's flagship Nexus 7 tablet. At 13.7 ounces, it's more than three ounces heavier than the Nexus 7, but much lighter than the original Shield.

On the back is a 5MP camera, on the front another 5MP camera and two speakers. Shield Tablet also sports Micro USB, Mini HDMI out, and a MicroSD card slot capable of taking 128GB cards. All of this is running a stock build of the latest version of Android KitKat (4.4), plus Shield Hub, an app used to buy, download, and launch games. Nvidia says it will update to Android L soon after Google's release.

But the real star of the Shield Tablet is Nvidia's new Tegra K1 mobile superchip. The 2.2GHz quad-core A15 SOC features Nvidia's Kepler GPU architecture and 192 CUDA cores, along with 2GB of low-power DDR3. K1 supports many of the graphical features in Nvidia's GeForce 3D cards, including tessellation, global illumination, and all that GPU jazz.

Until now, the original Shield's actively cooled Tegra 4 was one of the most powerful Android SOCs around. The passively cooled K1 slaughters it across the board. In 3DMark's mobile Ice Storm Unlimited test, the delta is an astounding 90 percent. Compared to the second-gen Nexus 7, the Shield Tablet benchmarks from 77 percent to 250 percent faster. This SOC is smoking fast.

As for battery life, Nvidia claims 10 hours surfing and five hours gaming, figures that we found fairly accurate. Of course, if you're going to game, you need Nvidia's new 11.2-ounce wireless Shield Controller. Sold separately for $60, it maintains the same button layout as the original Shield controller, but feels lighter and more comfortable to hold.

TAKING CONTROL

While most Android game controllers operate over Bluetooth, Nvidia opted for Wi-Fi Direct, citing faster response and more bandwidth. The bandwidth allows for linking up to four controllers, which is handy when you hook up to an HDTV via the Shield Tablet's Console Mode and its 10-foot UI. The controller also has a triangular clickable touchpad and an integrated microphone for voice commands, but notably lacks rumble support. To game on the tablet itself, you'll need to pay extra for the cover and stand. Still, you do get Nvidia's DirectStylus 2, which stows in the device's body and plays nicely with Nvidia's GPU-accelerated Dabbler painting app.

Games, of course, are why you're interested in the Shield Tablet, and it does come with a free Android copy of *Trine 2*, a PC game that looks great following its transition to the Shield. Nvidia says there are now around 400 Android titles that support its controller, but the straight truth is the overwhelming majority are garbage.

Nvidia, however, has worked with Valve to port over *Half Life 2* and *Portal* to the Shield. They look fantastic, easily the two prettiest games on Android. Emulators also run as well here as they did on the original Shield. Ditto GameStream, Nvidia's technology for streaming games from your PC to your Shield.

Nvidia says GameStream supports more than 100 PC games, including triple-A titles from EA's Origin and Valve's Steam platforms. The snag is the hundreds more great games that don't support the Shield Tablet's controller. But when GameStream does work, it's relatively lag-free and kind of wonderful. The one caveat is that you'll have to get a 5GHz dual-band router to really get it working.

Would we buy the Shield Tablet if we owned the original Shield? Probably not. We also think a bundled package with cover and controller would be nice. But it's a no brainer over the Nexus 7 if you're looking for a gaming tablet. All in, the Shield Tablet is pretty dang cool. **–JIMMY THANG**

VERDICT **9**

Nvidia Shield Tablet

+ ROSETTA STONE Super 8-inch screen; awesome streaming functionality; mega performance.

– LOST IN TRANSLATION Peripherals cost extra; controller compatibility; Android games suck.

$300, shield.nvidia.com

BENCHMARKS

	Nexus 7	Nvidia Shield Tablet	Percent difference
GeekBench single core	585	**1,114**	+ 90.4
GeekBench multi-core	1,880	**3,342**	+ 77.8
Antutu	20,333	**42,551**	+ 109.3
PassMark	3,193	**6,157**	+ 92.8
3DMark Ice Storm Unlimited	10,404	**31,396**	+ 201.8
GFXBench T-Rex	892	**3,116**	+ 249.33

Best scores are bolded.

SPECIFICATIONS

SOC	Nvidia Tegra K1 quad-core clocked at 2.2GHz with 2GB of DDR3L RAM
Size	8.8 x 5 x 0.3 inches
Weight	13.7 ounces
Storage	16GB
Display	1920x1200 IPS
Ports	Mini HDMI output, Micro USB 2.0, MicroSD storage slot (that supports up to 128GB cards), 3.5mm headphone jack with microphone support

MSI AG270 2PE All-in-One Gaming PC

A true AIO designed for gaming

IT'S BEEN A WHILE since we've reviewed a "gaming all-in-one" PC, so it's refreshing to get MSI's AG270 in our lab. The AIOs we usually get come with weaksauce mobile GPUs such as Nvidia's 630M, or worst yet, no discrete graphics card at all. That isn't the case with this AIO, which comes with the GeForce GTX 880M. For those unfamiliar with this top-of-the-line mobile GPU, it has a 954MHz graphics clock and 8GB of GDDR5 VRAM that's clocked at 2,500MHz. As far as mobile GPUs go, there are none faster at the moment.

But the first thing you'll notice is this AIO's 27-inch touchscreen monitor. With a chassis measuring 2.6x26.5x19.5 inches, it's big. Aesthetically, it's mostly black with streaks of red and some MSI dragon logos sprinkled about. It's not too garish, but lets you know it isn't a regular AIO. All propped up on a single sturdy leg, you can bend the AIO back 45 degrees. You can also secure the monitor on a VESA mount.

Speaking of the monitor, it's a 1080p screen. While most other AIOs use the same resolution, we're a bit disappointed, considering this machine has a powerful GPU. We don't need 4K here, but is 2560x1440 too much to ask? The screen is actually a bit of a letdown in general. It uses a matte non-glare display, but it ends up having a slight white haze to it. We did experience an odd issue in Steam's Big Picture mode, where the screen would flicker, but we suspect the problem lay with drivers or software rather than hardware. The monitor isn't a deal breaker, however, and even features "less blue light," which MSI claims relieves eye strain. In addition, the screen features very responsive digitizers, and finger painting with its 10-point touch screen was as responsive as we've ever seen on an AIO.

THE FAST AND THE FURIOUS

But what really separates the AG270 from other AIOs are its enthusiast components. The star of the show is the aforementioned 880M GPU, which ran multiple circles around our Asus ET2300 zero-point's 630M counterpart. We're talking on a scale of 400 to 500 percent or more. It's not going to run games maxed out, but it should run most AAA games on high with playable frame rates. While the gains from the 2.4GHz Core i7-4860HQ CPU weren't quite as dramatic, it still outperformed our ZP's 3GHz Core i5-3330 by 20 to 25 percent, which is quite impressive for CPU gains.

It's also far from being a slouch in the storage department. Featuring two 128GB SSDs in a blazing-fast "Super RAID 2" configuration, it showcased read and write speeds of 1,048MB/s and 633MB/s in CrystalDiskMark, respectively. Super RAID 2 supports up to three mSATA devices in RAID while supporting trim on the SSDs. The AIO also features 802.11AC to ensure you get the fastest online gaming experience possible over Wi-Fi. And there's a 2TB HDD for mass storage and 16GB of RAM to round out the package.

In terms of physical ports and features on the package itself, the G270 has Ethernet, VGA, HDMI-in/out, four USB ports on the back, plus 3.5mm headphone and mic jacks. On the right of the monitor is a Blu-ray burner, on the left two USB 3.0 ports, volume buttons, monitor adjustments buttons, and power button.

While most modern AIOs ship with a wireless keyboard-and-mouse combo, the MSI AG270 comes with wired equivalents. Considering this is designed as a gaming AIO where a little input lag can mean the difference between virtual life and death, we don't mind the cables too much. What does bother us, however, is the fact that both accessories are subpar, especially the keyboard. It feels flimsy and the keys are janky enough to hamper your typing experience. We also didn't like that the main Enter key is tiny. Still, you could always spend a little more money to purchase a real set of gaming peripherals.

Of course, this adds to the cost, which is this AIO's biggest issue. At $2,600, you're paying a premium for the form factor. You could easily build a much more powerful PC for less dough, going the traditional DIY desktop route, and you'd have something more modular in the long run. If you have to get your gaming fix with a touchscreen AIO, however, you could certainly do worse than MSI's AG270. –JIMMY THANG

VERDICT **8**

MSI AG270 2PE All-in-One Gaming PC

+ MOBILE Powerful mobile GPU and CPU; great all-round specs.

– IMMOBILE Expensive; mediocre monitor.

$2,600, www.msi.com

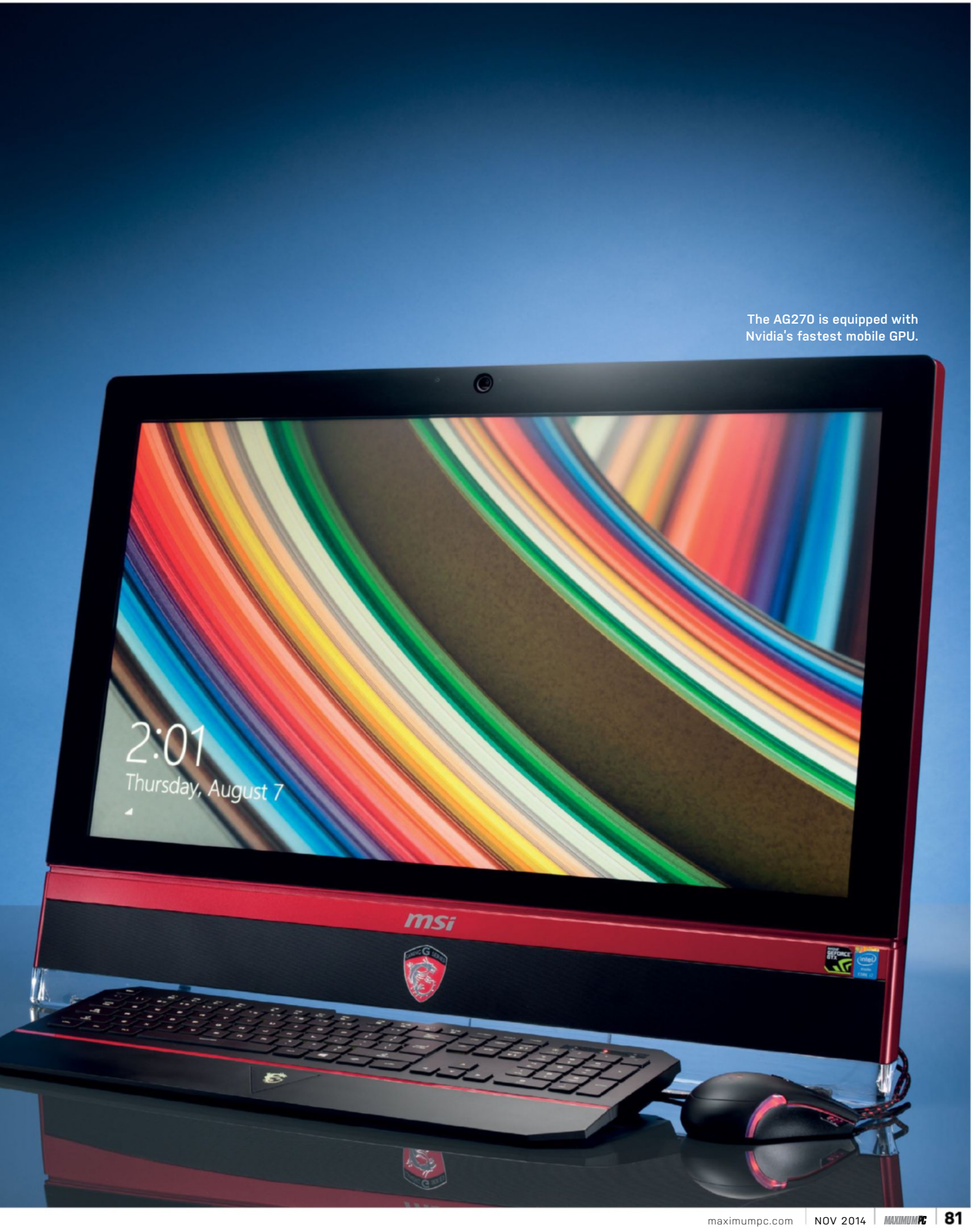
BENCHMARKS

	Zero-point	Tested system	Percentage difference
Stitch.Efx 2.0 (sec)	1,192	957	24.6%
Proshow Producer 5 (sec)	1,841	1,534	20%
x264 HD 5.0	9.9	13.3	34.3%
Metro 2033 (fps)	22	110	400%
3DMark 11 Perf	1,333	8,363	527.4%

Our zero-point all-in-one PC is an Asus ET2300 with a 3.0GHz Intel Core i5-3330M, 8GB DDR3/1600, 1TB 7,200rpm hard drive, a GeForce GT 630M, and Windows 8. *Metro* tested at 1280x768 with Medium settings, Tessellation enabled.

SPECIFICATIONS

CPU	2.4GHz Intel i7-4860HQ
GPU	Nvidia GeForce GTX 880M
RAM	16GB DDR3/1600
Storage	2x128GB SSDs, 2TB HDD
Optica	Blu-ray burner
Display	27" LCD 1920x1080 (matte)



The AG270 is equipped with Nvidia's fastest mobile GPU.

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The HDHomeRun Plus's flexibility is countered by its quirks.

Silicon Dust HDHomeRun Plus

A grand slam for some, a foul ball for others

WE LIKE FREE. We also like doing things ourselves, which is why building our own DVRs to capture OTA broadcasts has been a habit for years. And we're fans of devices that give us wide flexibility and range in their use. Given all these preferences, Silicon Dust's HDHomeRun Plus—a network-based external TV tuner—fulfills all our wants, on paper. In practice, it very nearly does likewise.

Initial setup for the HDHomeRun Plus is super easy: plug in the power connector, an Ethernet cable, and your antenna's coaxial cable, then download Silicon Dust's software from the company's website and install it. Running the setup—to scan for channels and to set the default programs for watching live TV and recording TV—takes 10 minutes. You can then watch broadcasts immediately through the Silicon Dust's HDHomeRun Live TV software or Windows Media Player. You can also use VLC, but setting it up is far trickier.

The experience begins to diverge, however, when you move on to setting up PVR software. When we tried the HDHomeRun Plus with Windows Media Center as our recording program, getting our home brew DVR off the ground was as easy as opening WMC and tweaking its settings to scan channels and input the correct location info for the channel guide. Trying NextPVR—the other officially supported piece of Windows PVR software—was far more frustrating. On our Windows 7 machine, running the installer caused our system to lock up and required either force-closing the installer or a soft reset; on our Windows 8 machine, we installed the program, but it couldn't detect any channels through the tuners, despite repeated tries.

Equally split is the quality of the device's streaming functionality. When accessed from computers or DLNA devices, audio-video syncing is excellent and the feed has the same crispness as a direct connection from the OTA antenna to a TV. But on mobile devices, audio was consistently ahead of video—an annoying fail given the app to watch live TV costs an additional $2.

Using the HDHomeRun Plus can go one of two ways, depending on which path you take. If you're a Windows 7 user, comfortable with Windows Media Center, and plan to watch TV through your HTPC or a media extender (such as an Xbox 360), the Plus will work perfectly and offers good flexibility for viewing options. If you're running Windows 8, want to use NextPVR because it's free and also not WMC, or plan to do a lot of your live TV viewing through a mobile device, the HDHomeRun Plus becomes less of a surefire hit. But regardless of the scenario, you'll have to contend with one inescapable fact: its fan is annoyingly loud when the device is transcoding. If you can handle the noise, or you're able to stash it somewhere remote, this downside might be tolerable. For us, it was a bit of a deal-breaker when combined with the mobile device performance—and that's despite how much we liked using it with a Windows 7/WMC configuration. –ALAINA YEE

VERDICT **7**

Silicon Dust HDHomeRun Plus

+ GUINNESS Network-based TV tuners; easy to set up when used with Windows 7 and WMC.

– BUD LIGHT Have to pay for mobile app; poor app performance; difficult to set up with NextPVR.

$170, www.silicondust.com

Even though its temps got up to 100F during testing, the Extreme Pro was barely warm to the touch.

SanDisk Extreme Pro

No amateurs around here

IN THE WORLD OF PC TECHNOLOGY, there's always a bottleneck somewhere in the platform. For years, hard disk drives were arguably the worst offenders, poking along at about 150MB/s while the rest of the PC could communicate in GB/s. The third version of SATA can truck along at up to 550MB/s, and it took some time for solid-state drives to mature and hit those speeds. Now, pretty much every SSD manufacturer can mash the gas pedal, making price a more compelling factor than performance. This is where the SanDisk Extreme Pro finds itself now: super fast... just like everyone else. How, then, do you distinguish yourself?

There's the warranty, for one thing. SanDisk guarantees this drive for a whopping 10 years. That's twice the length of the next best one we've seen. Very few storage devices stay relevant for that long, given our constantly ballooning need for more space, but it's nice for a manufacturer to back anything for this long. SanDisk also provides its "SSD Dashboard," which is an upgrade from its previous "SSD Toolkit" software. Dashboard gathers a number of functions under one roof, such as manual trim operation and scheduling, drive erasing, and SMART data collection. The program also provides shortcuts to the Windows Disk Manager, System Properties, and the Device Manager. Advanced users won't have much need for this presentation, but Dashboard also lets you quickly toggle write-cache buffer flushing, which you want to disable for performance testing—as the program indeed tells you.

SAMSUNG IN ITS SIGHTS

While the industry-wide performance chart is crowded at the top, there is still some room for a drive to distinguish itself. In our tests, the Extreme Pro came out right alongside the Samsung 840 Pro, which has been the gold standard since it appeared two years ago (though the 850 Pro will have replaced it by the time you read this). Part of this boost may be due to SanDisk's "nCache Pro," which caches close to 1GB of user data. It's not as impressive as Samsung's 12GB "TurboWrite," but when the SanDisk unit can still outperform an 840 EVO in our Sony Vegas test, the Extreme Pro is clearly still getting the job done—its Vantage and IOPS scores are well below average, but all of our other benches put it at or near the top of the heap.

SanDisk adds an additional twist by offering a 960GB model, a first for the company and only the third unit to join the high-end segment. As this issue went to press, you could pick one up from Amazon for $545 (though we reviewed the 480GB model going for $335). The 1TB 850 Pro, meanwhile, came in at $700, and the 512GB model started at $400. So, neither is competing on price—you could pick up a 512GB Crucial MX100 for $220, just about half the price. On the flip side, Crucial gives you a three-year warranty and no software, so there are trade-offs. If you want a firmware update, which can sometimes be critical to proper operation, you'll have to go digging through the company's website.

But there's one notable trade-off with the Extreme Pro as well, and that's the lack of hardware-accelerated disk encryption (which the MX100 has, among others). That feature allows you to encrypt your data with only a minor loss in I/O speeds, and with much reduced CPU overhead. With that in mind, we don't recommend installing this unit in a laptop unless you don't mind the performance hit of doing encryption in software. With the gathering storm of SATA Express and M.2 drives on the horizon, people who move a lot of data around might just want to wait. –TOM MCNAMARA

BENCHMARKS

	SanDisk Extreme Pro	SanDisk Extreme II	Crucial M550	Samsung 840 Pro	OCZ Vertex 460
Controller	Marvell	Marvell	Marvell	Samsung	Barefoot 3
Capacity	480GB	480GB	1TB	256GB	240GB
Warranty	10 years	5 years	3 years	5 years	3 years
CrystalDiskMark					
Avg. Sustained Read (MB/s)	**531**	521	501	517	489
Avg. Sustained Write (MB/s)	**503**	484	482	498	488
AS SSD – Compressed Data					
Avg. Sustained Read (MB/s)	**514**	508	**514**	DNT	503
Avg. Sustained Write (MB/s)	486	473	478	DNT	491
ATTO 4QD					
64KB File Read (MB/s)	474	**525**	466	517	519
64KB File Write (MB/s, 4QD)	524	493	470	**545**	479
Iometer IOPS					
4KB Random Write 32QD (IOPS)	44,334	42,699	**84,748**	49,238	65,242
PCMark Vantage x64	47,055	38,093	**76,251**	68,160	72,435
Sony Vegas Pro 9 Write (sec)	**272**	275	315	421	323

Best scores are bolded. All tests are conducted on our hard drive test bench, which consists of a Gigabyte Z77X-UP4 motherboard, Intel Core i5-3470 3.2GHz CPU, 8GB of RAM, Intel 520 Series SSD, and a Cooler Master 450W power supply.

VERDICT **9**

SanDisk Extreme Pro

+ FLASH GORDON Stellar speeds; industrial-strength warranty; useful software.

– INDECENT EXPOSURE Relatively pricey; no hardware-accelerated encrytion.

$335, www.sandisk.com

The NZXT logo lights up in different colors, according to temperature.

NZXT Kraken X41

We like 'em thick

MOSTLY KNOWN FOR ITS CASES, NZXT has a formula for its closed-loop liquid coolers: make them bigger. When most everyone else was producing 120mm or 240mm radiators, NZXT introduced its 140mm and 280mm CLCs. That allowed NZXT's units to be quieter than its competitors. But like any first-generation product, it wasn't perfect. The company responded with the X61—which we reviewed last month and awarded a 9 Kick Ass—and now the X41, which is getting the full MC treatment this issue.

IN IT FOR THE LONG HAUL

Like the X61, this unit's warranty has been boosted from one year to six years—the longest in the industry. You may scoff at a longer warranty, but when a company stands behind its product for longer, it's generally a sign it may actually last longer, which can't be a bad thing. NZXT also upgraded its software to monitor more elements of the system and even allow you to do so remotely. Right now, it's only possible via another desktop over the Internet, but NZXT has plans to produce mobile apps for Android and iOS, which should be available by the time you read this. Also, like the X61, this unit's tubing has been extended from 12 to 16 inches for more installation options, and the fans now integrate rubber/silicone mounting points to reduce vibration. Unlike the X61, the X41's radiator has been thickened from the standard 25mm to 36mm. This larger surface area is supposed to improve cooling, provided the fan has enough static pressure to handle the larger rad.

More good news is that CLC installation is even more straightforward than with the X61, because there's no SATA power connector to deal with. Everything is powered through a 3-pin fan cable that comes out of the block that sits on top of the CPU. You normally need a fourth pin to do automatic fan speed adjustments, but there's a separate cable that plugs into an internal USB motherboard header. This is how NZXT's "CAM" software sees and controls the cooler. The fan itself plugs into a splitter cable that can take an optional second fan, and NZXT provides the additional screws you'd need for that scenario. Considering the additional thickness of the radiator, though, you'll definitely want to measure the inside of your case before going that route.

QUIETLY DOES IT

The copper plate that sits on top of the CPU also has the usual pre-applied thermal paste, but we clean that off and apply Zalman STG2 for testing instead. An Intel CPU bracket is installed at the factory, as has become the norm, but you can just whip that off and twist the bundled AMD bracket on instead, if need be. The X41 uses the same adjustable backplate as the X61, and has a sturdier feel than the item used in the previous generation of NZXT CLCs. It might not be metal, but at least the screw threading within the backplate is metal this time, and that long warranty feels reassuring.

And like the X61, the X41 is amazingly quiet. Its "silent" mode when idle spins the fan at only 500rpm. Even "performance" mode, when handling our torture-test benchmark, only brings the fan up to 75 percent of its max speed, or 1,500rpm. So, temperatures across the board are noticeably higher than the competition, but you can still manually push the fan all the way to 2,000rpm, if you don't mind the noise. Unfortunately, the fan rattled a little when pushed past 1,500rpm; it's a bit tricky to make it totally level, because the rubber mounting points have some give. So if you want raw performance, you're arguably better off with a Corsair H80i or a cooler with a 240mm radiator. But when it comes to noise level, it's hard to beat 140mm fans, and hard to beat the X41 in particular.

–TOM MCNAMARA

VERDICT **9**

NZXT Kraken X41

+ SIR MIX-A-LOT Very quiet operation; easy to install; polished software.

– MAXED OUT Need to tweak fan speeds to get ideal temps; fan can rattle.

$110, www.nzxt.com

BENCHMARKS

	NZXT Kraken X41 Quiet / Performance Mode	Silverstone Tundra TD03 Quiet / Performance Mode	Cooler Master 212 EVO Quiet / Performance Mode	Antec Kuhler 950 Quiet / Performance Mode
Ambient Air	20.5 / 20.8	20.7 / 21	**20.5 / 20.3**	22 / 22.3
Idle Temperature	31.5 / 34.8	**30 / 29.2**	35.5 / 30.5	38 / 32.2
Load Temperature	77.3 / 67.6	**68.8 / 65**	70 / 67.3	72.1 / 67.7
Load – Ambient	56.8 / 47.1	**47.8 / 44.3**	49.5 / 47	50.1 / 45.4
Street Price	$110	$98	$35	$99

Best results are bolded. All temperatures in degrees Celsius. All tests performed with an Intel Core i7-3960X at 4.1GHz, on an Asus Rampage IV Extreme motherboard in a Corsair 900D with stock fans set to Standard.

SPECIFICATIONS

Dimensions (H x D x W)	6.8 x 6.7 x 4.7 inches
Weight	3.5lbs
Stock Fans	14cm PWM
Socket Support	LGA 1150/1155/1156/1366/2011-3; AM2/AM2+/AM3/AM3+/FM1/FM2
Additional Fan Support	1x 14cm

It's probably the best gaming panel yet, so why are we disappointed?

Asus PG278Q ROG Swift

All hail the messiah of monitors

THIS IS IT. THE ONE. The PC monitor that has everything. 1440p pixel grid, 144Hz refresh, 1ms response, Nvidia's G-Sync technology—the works.

On paper, the new Asus ROG Swift doesn't just tick all our boxes for the ultimate gaming monitor. It mashes them into whimpering submission. It's the screen we've been waiting for. And before anyone pipes up about TN versus IPS panel technology, the latest 28-inch 4K monitors have proven that TN can be properly pretty. End of that debate, therefore.

In that context, and assuming it delivers, we can just about swallow the Asus's swollen $800 sticker price. But beyond the headline specs, what exactly are you getting? As an ROG item, it's premium through and through. The chassis and stand are fully adjustable, while the overall look and feel is simply expensive. The best bit is the super-slim and near-flush screen bezel. But the power and status light that forms a full ring around the swivel point on the stand is pretty darn snazzy, too.

Inputs-wise, you're actually limited to just a single DisplayPort socket. Problematic? Penny pinching? Not in our esteemed view. This is a panel with a very particular purpose. And due to the bandwidth requirements of driving a 1440p pixel grid beyond 60Hz, that purpose can only be achieved with DisplayPort.

Likewise, we're not bothered by the lack of pointless image-processing frills such as dynamic contrast. There's a triple-level option for pixel overdrive (the middle setting is the best compromise between speed and inverse ghosting). And that's it.

On, then, to the critical question of image quality. First the bad news. Immediate impressions make it absolutely obvious this new 1440p TN panel can't match those awesome 28-inch 4K TNers for raw, unadulterated image quality.

We're not talking here about sharpness or anything relating to resolution or pixel pitch. Instead, the issues are things such as contrast, vibrancy, perceived depth, and viewing angles. Before the 28-inch 4K generation appeared, the Swift would probably have had a shot at being rated as the very best TN screen we'd ever seen.

But as good as it is—and it is very good by broader TN standards—things have moved on dramatically, and that makes the Swift slightly disappointing. Elsewhere, it's much better news. As ever, 144Hz is just glorious—on the desktop, in-game, everywhere. Once you've gone high refresh, you won't ever want to go back.

As for Nvidia's G-Sync technology, it's unfortunately a little more hit and miss. When it works, it's lovely. No rips, no tears, no judder, no stutter. Most of the time it does work. But the effects are relatively subtle and it can be hard to absolutely verify correct operation. A bit like multi-GPU scaling, the benefits are undeniable, but it will occasionally drive you mental wondering whether or not it's working.

As for the gamer-critical issue of input lag, Asus has certainly done its homework. This thing is seriously quick in standard mode and we couldn't detect any of the mooted—by AMD, rival to G-Sync innovator Nvidia, it has to be said—drop-off with G-Sync enabled.

All of which means the ROG Swift somehow manages to be very possibly the best purist gaming panel we've ever seen and yet still a disappointment. The problem is the breakneck speed of monitor development of late—4K, high refresh, synced refresh, super-wide aspect ratio, and improved panel tech. As things stand, no single monitor has yet brought it all together. Despite the Swift's messianic promise, the wait continues. **–JEREMY LAIRD**

VERDICT **8**

Asus PG278Q ROG Swift

HIGH REFRESH Awesome feature set; very high quality overall package; super-quick response and refresh.

LAME REHASH TN panel is slightly disappointing; very expensive.

$799, www.asus.com

SPECIFICATIONS

Panel size	27-inch
Panel type	TN
Native resolution	2560x1440
Max refresh	144Hz with Nvidia G-Sync
Response	1ms
Inputs	DisplayPort, USB 3.0

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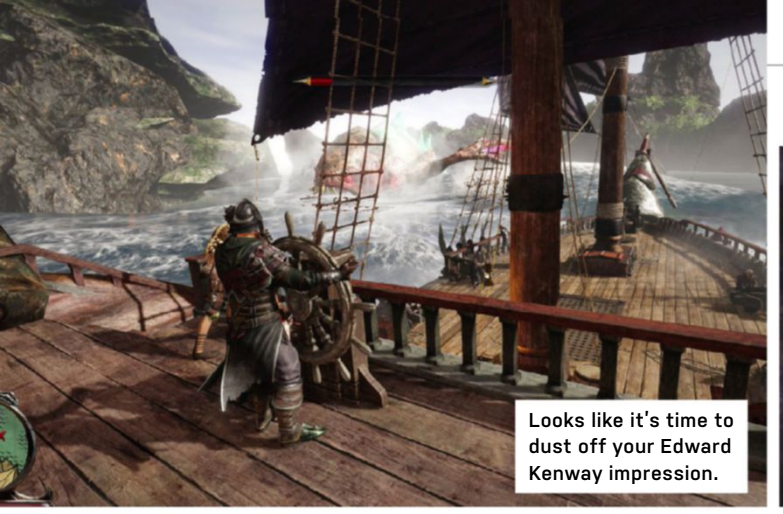
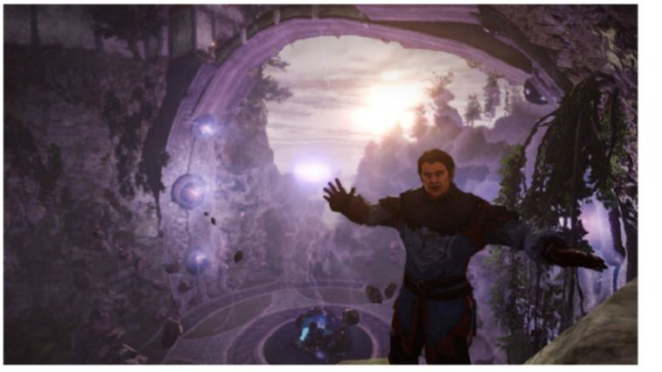


Looks like it's time to dust off your Edward Kenway impression.



Risen 3: Titan Lords

Like its hero, this series is back from the dead

PIRANHA BYTES KNOWS you probably didn't like *Risen 2*, and so the studio symbolically kills it off just 30 minutes into this sequel. There's our hero from 2012's pirate-themed adventure—still nameless and looking as if he's wandered out of *Assassin's Creed IV*—but piracy apparently isn't what you want, so he dies without even a final "Arr."

And then he is risen. After three weeks fermenting in the tropical sun, his corpse is brought back to life by a loopy shaman. Piranha revives the series with him, and fittingly sends him off to find his soul. The generally fun romp takes him into caves hiding menacing shadow lords, and into bleached dreams where he waxes philosophical with villains from *Risen*'s past. But happily it's not a game demanding encyclopedic knowledge of its forebears—*Titan Lords*' tale of powerful mages stands well on its own.

The three new factions you can align with are largely to thank for that. The voodoo of *Risen 2* makes a return in the camps of the Natives, but they never steal the show quite like their neighbors. The Guardians serve the Mages on their rocky isle, but their melee prowess (and gear) adds a welcome edge to the spellslinger faction by leaving them with a degree of sheer physical grunt. Scowling on stage left, we have fellow Demon Hunters, who bring Conan-style grit to the proceedings.

More importantly, the three factions bring magic. This enhances *Risen 3* so thoroughly it's appalling to think its predecessor shipped without it. A chief criticism of *Risen 2* was that the tendency of enemies to gang up on you kept you from attacking, but here we send them flying back with a spell such as the Demon Hunter's Shockwave. While they're wiggling in shock, we whip out a crossbow and—thoonk, thoonk, thoonk—they collapse like dominoes. It's stupid fun.

But let's be candid: it takes a while to reach this state of combat nirvana. *Risen 3* wisely isn't so stingy with gold and gear as its predecessor—nor does it leave the locations of quest objectives open to guesswork—but its core combat does rely on the same dubious dance of parrying, heavy attacks, and slashes, despite fancy new animations. *Risen 3* is strikingly bug-free considering the series' reputation, but sometimes obvious hits miss and relentless enemy attacks break seemingly well-timed blocks.

But then this is a world where Glory is earned by killing chickens. Glory is everywhere, and it's used to boost stats that affect our hero's prowess in skills such as Melee or Influence. It's a versatile system, and one that enabled us to turn our Demon Hunter into a battle mage of sorts who wreaked havoc with his battle axe while summoning demon dogs. And situations abound. There's a pleasing balance of combat and story, seasoned with mini-games in which you lockpick or arm wrestle for extra gold. And bless our beards, the ship battles! Somebody's been playing *Assassin's Creed IV*, and it's paid off, with our hero nabbing a ship and clashing with sea monsters just as the rest of the game is slipping into a predictable rhythm.

Any concerns? Well, it's not exceptionally pretty—*Risen* frankly looks old. But we still don't want to stop playing. –LEIF JOHNSON

VERDICT **8**

Risen 3: Titan Lords

TREASURE CHEST New magic elements are great fun; lots of situations and mini-games; awesome ship battles.

SHIVER ME TIMBERS Graphics dated and muddy; still some combat bugs.

$50, www.deepsilver.com, ESRB: M

LAB NOTES

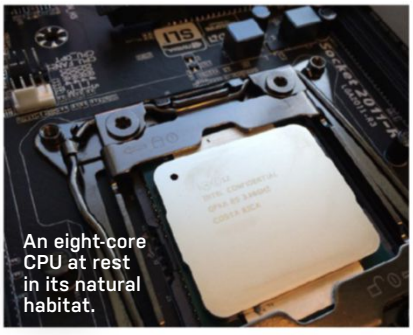
TOM MCNAMARA **ASSOCIATE EDITOR**

Intel's Workstation Turning Point

It's more than just two extra CPU cores

SINCE I STARTED AT MAXIMUM PC in February of 2013, there hasn't been much on the CPU front to get particularly hyped about. I mean, AMD has released a steady stream of APUs, but those aren't the kind of thing that gets my motor running. Intel's CPUs with the 128MB L4 cache are interesting, but they can't be found at retail. However, the high end is finally changing with Intel's first eight-core desktop chip. AMD's FX-8350 is eight-core if you accept that it has four floating-point units. But for me, the Core i7-5960X is the first true octo-beast outside of enterprise data centers and suchlike.

Do we actually need a chip with 16 threads? About 95 percent of the time, probably not. It's pretty niche. At the same time, though, I've seen a few high-end PC games happily chew up six threads on a Core i7. And professional HD video editors will genuinely benefit from as many cores as Silicon Valley can provide, which you've seen from the benchmarks. At a stock clock speed of 3GHz (turbo up to 3.5GHz), the 5960X smokes a six-core Core i7-3960X that's been overclocked to 5.0GHz on all cores. That's very exciting. Never mind that this platform finally has native USB 3.0, plus SATA Express and M.2 connections (although not native on the last two), and DDR4. I think we can officially put a fork in the original LGA2011 platform.



An eight-core CPU at rest in its natural habitat.

Of course, you only get the eight-core magic if you drop a thousand bucks for the top-end part. It hearkens back to the days when Intel used to sell its regular top-end desktop chips for around that much—before AMD's Athlon 64 came on the scene and blew everything up. But without AMD competing at that tier these days, Intel can decide how to cut the cake and choose which slice to give you. It's unfortunate, but it's also the reality of supply and demand. On the bright side, most people don't need that kind of horsepower anyway. If you're in the minority that does, then you or your employer is probably in a position to just go out and buy it.

JIMMY THANG

Online Managing Editor

Best Buy is predicting the tablet market is going to crash. It makes sense, when you think about it. People use tablets as consumption devices, but they suck for productivity. As a result, it seems like the majority of people don't need the latest, greatest, most powerful tablets if all they do with them is read e-books all day. The tablet they already have is probably good enough for the foreseeable. Result? The tablet market is clearly nearly saturated. I predict that notebooks will make a resurgence once people realize, "Hey, I can actually watch *and* make Youtube videos on a laptop." I'm calling it now, notebooks are going to be chic again.

GORDON MAH UNG

Editor-in-Chief

I may sound like a broken record that's been sampled, synthesized, put in a drum machine on a permanent loop and then uploaded in 24-hour format onto Youtube. But after being forced to use an iPhone for two months, I can't stand it. It reinforces absolutely everything I've come to despise in an operating system that has no freedom, no diversity of platform or parts, and one tiny little screen. I mean, you can't even change out the keyboard, which is horrible. Yes, the interface is (generally) a little smoother than my Android handset of choice, but then the trains run on time in most dictatorships, too.

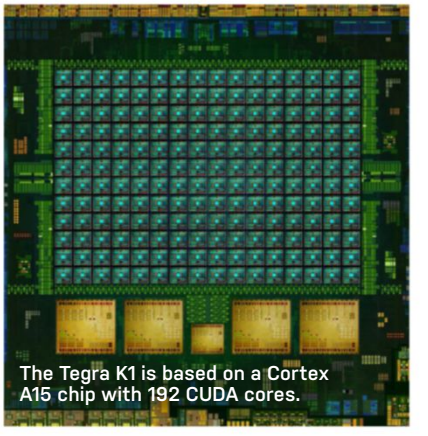
First Look: Tegra K1 in a Chromebook?

Acer unveils its first ARM-based Chromebook using an Nvidia Tegra K1

INTEL MAY RULE the roost when it comes to Windows and OSX-based laptops, but the company is increasingly facing competition in an unexpected area: Google Chrome OS–based devices.

For those who still don't know about Chromebooks, as they're called, they're purpose-designed clamshell laptops with a lightweight Linux-based OS that's a delivery system for the Chrome browser. They are, essentially, today's thin clients with just about everything done in the cloud. They originally used Intel's Atom processors, but vendors soon graduated to Celerons and even Core i5 CPUs. They didn't just stick to just x86 though—Samsung began offering Chromebooks using its own Exynos ARM-based CPUs instead of Intel parts, and HP followed suit. With predictions of a booming market for Chromebooks, Acer has now joined the battle with its Acer Chromebook 13 featuring an Nvidia Tegra K1 ARM CPU.

Acer has had great success here—we've long rated its C720 as our recommended Chromebook—so the company's first ARM Chromebook with an Nvidia CPU really piques our interest. The 2.3GHz quad-core Tegra K1 is already recognized as one of the faster ARM chips around. On paper it should outbox Samsung's dual-core A15-based Exynos 5 parts, but what about Intel's parts? Nvidia claims it will whup Samsung Exynos and Celeron butt, thanks to better power consumption and graphics performance—



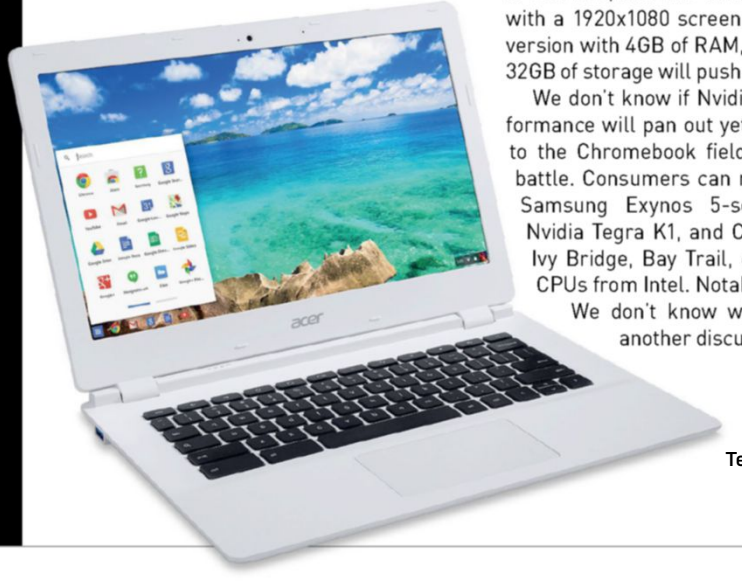
The Tegra K1 is based on a Cortex A15 chip with 192 CUDA cores.

the Tegra K1 uses five times less power than the popular Intel Celeron parts used in mobile devices, says Nvidia, plus has five times the graphics grunt of a Bay Trail-based Celeron N2830 and Exynos 5800-series chip.

Nvidia sees the graphics advantage as key. It says the Chromebook 13 is one of the very few that can handle a 10-way Google hangout without the video chunking out. The Chromebook 13 will feature a 13.3-inch screen and come with either a 1920x1080 or 1366x768 resolution screen. With its larger chassis size and power-sipping ARM cores, Nvidia says the Chromebook 13 should offer a stellar 13 hours of battery life.

An Acer Chromebook 13 with a 2GB RAM, 16GB of storage, and 1366x768 is expected to sell for $280. The same Chromebook 13 with a 1920x1080 screen will cost $300. A version with 4GB of RAM, 1080p panel, and 32GB of storage will push it to $380.

We don't know if Nvidia's claims of performance will pan out yet, but its entrance to the Chromebook field makes it a true battle. Consumers can now pick between Samsung Exynos 5-series CPUs, the Nvidia Tegra K1, and Chromebooks with Ivy Bridge, Bay Trail, or Haswell-based CPUs from Intel. Notably absent is AMD. We don't know why, but that's for another discussion. **–GU**



The new Acer Chromebook 13 features a 2.3GHz Tegra K1 chip inside.

GEEK TESTED & APPROVED

Vector Cupholder

NOBODY LIKES SPILLING their double mocha frappuccino on a newly purchased laptop. But the longer you own a mobile device, the greater the probability you will wreck your whole day by either dropping it or spilling something on it. Enter Vector Werks, a small industrial design shop run out of New England by attorney and inventor Cliff Thier. His Vector Cupholder is an aluminum job that clips on to the side of your table, keeping your drink clear from swinging arms and pointy elbows. When not in use, it folds down for travel in a briefcase or work bag. Fifty bucks probably isn't your ideal price point, but machining this material isn't cheap, and these widgets aren't being mass-produced by a fleet of robots. It's also not a bad insurance fee to safeguard hardware that can be worth thousands. $50, www.vectorwerks.com **–TM**

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Where Are the OLED Monitors?
> Dream Machine: Overkill?
> Evaluating 840 EVO and PRO

Will OLED Monitors Ever Arrive?

It took a while to see OLED screens for TVs because manufacturers initially said they couldn't scale up the process from putting them in mobile devices efficiently. Now that there are 50-inch-plus OLED TVs, we have OLEDs on the small end and large end of the screen-size scale—so why don't we have OLEDs in the 20–30-inch range for monitors? Is there a technical reason? I would've thought there would be OLED monitors popping up as manufacturers scaled their way up to TV sizes, but apparently not. We got skipped. Why?

—T

Freedom isn't free.

CONTRIBUTING EDITOR ALAINA YEE RESPONDS: I'm not sure if it's so much "skipped," as it is we're still standing at the back of the line. Right now, with production costs being as high as they are for large-screen OLED TVs (a 55-inch OLED TV is about $9,000, while a comparably sized LCD TV is $1,600 on the high end), and with all but one of the big-name TV makers pulling out of the OLED field for the moment, I don't think the scale or demand for OLED TVs is large enough yet for anyone to move onto making monitors. Plasma orginally started this way as well, though; so perhaps in another five-to-seven years we'll see OLED TVs reach acceptable prices, and a trickle-down effect will finally hit the monitor space. Still, it's not like we don't have any options—if you've got the scratch, there's a $5,500 25-inch Sony OLED monitor you can buy.

Dream Overkill?

I just read your "Dream Machine 2014" feature [September issue]. Don't get me wrong, while it is extremely impressive, I don't understand why you would use two PCs. I've been a *Maximum PC* reader for a long time, and up to now the Dream Machine has been a no-holds-barred, pull-out-all-the-stops kind of build—but of a single PC. This single PC is meant to run everything at its very best, but with two PCs you have to make a choice: Do I use green or red? Both systems have their advantages and disadvantages, but in the end, how do you choose? Do you use one for gaming exclusively and the other for video or picture editing? Do you game on both? If gaming on both, how do you choose which game is played on which PC? In the end, it's this choice that I think takes away from this year's build.

—Igor

EDITOR-IN-CHIEF GORDON MAH UNG RESPONDS: I think you'd choose based on the game and what you feel like. Physx game? Play it on the dual Titan Zs. Mantle game? Play it on the Radeon cards. If the workload needs tons of threads, spool it up on the Ivy Bridge-E box. See? Free choice is good.

EVO Differences

Longtime subscriber here, just curious if the Samsung 840 EVO holds up to your general sentiments towards the 840 PRO, especially since the EVO 1TB is only $440 on Amazon, and the PRO is nearly as much for 512GB. Thanks!

—Chris Cardinal

ASSOCIATE EDITOR TOM MCNAMARA RESPONDS: The 840 Pro's sheer performance is helpful for professional editing of HD video and batches of hi-res photos, where you'll be moving a lot of data on and off the drive and wrangling tight deadlines. The warranty is also a tempting five years instead of three. However, for less demanding uses such as running Windows, games, spreadsheets, and Internet streaming, the 840 EVO won't perform much differently at all.

↘ submit your questions to: comments@maximumpc.com

In a Galaxy Far, Far Away

In your "Head to Head" feature of your September 2014 issue, you use the phrase: "We don't believe that for a parsec." You do understand that a parsec is a measure of distance, not time, and a very large one at that? I would expect the editor-in-chief of a magazine such as yours to know that. Jus' sayin'.
—Mike Garcia

I am a longtime *Maximum PC* reader and an amateur astronomer. When I read "Head to Head" in the September issue, by Gordon Mah Ung, I just had to write. Gordon, and also Hans Solo, think a parsec is a unit of time. It's a unit of distance! Parsec is a shortened form of parallax of one arc second, which works out to 3.26 light years, or 19 trillion miles. Maybe taking Astronomy 101 might help.
—Greg Furtman

> MY BRAIN IS CAPABLE OF CALCULATING OBSCURE *STAR WARS* REFERENCES AT FASTER-THAN-LIGHT SPEEDS.

EDITOR-IN-CHIEF GORDON MAH UNG RESPONDS: Just like the *Falcon*, my brain is capable of calculating obscure *Star Wars* references at faster-than-light speeds. As you know, Hyper Space jumps work like a wormhole and fold space, thus making distances shorter. So, when I make obscure movie or television references, I am actually folding the space-time continuum in nano-parsec distances between the brain nodes. What would normally be a 12-parsec thought jump, turns into an 11.999-parsec thought. In other words, I trolled everyone on purpose but didn't realize that maybe it was too obscure. Oh, and I just flushed my Bussard scoops, too.

[NOW ONLINE]

A CRASH COURSE IN ADOBE LIGHTROOM

Have you ever wondered how professional photographers' pictures look so amazing? In addition to their shooting skills, they almost all tweak their photos in post. Truth be told, those high contrast/wonderfully saturated images are often enhanced after the shoot. The editing process has become an art unto itself. Yes, this means it can also be an intricate and complicated mess to learn, but that's why we're here. In our Lightroom Crash Course, we show you how to use the meat and potatoes of Adobe's powerful, affordable photo-editing software, so your photos can start looking like the pros'. http://bit.ly/1A8ztS8

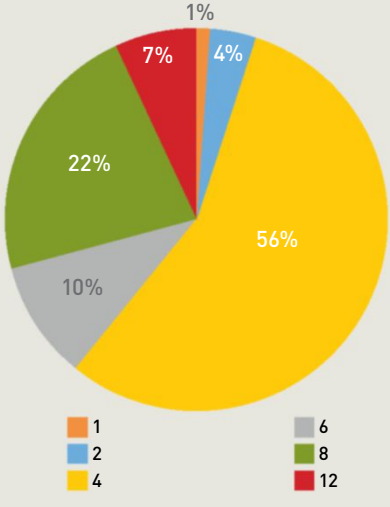
Facebook Polls

Will you build on Haswell-E or wait for next year's Skylake?

This month, we wondered about the general excitement around Intel's new chip, so decided to ask our Facebook readers to help us out. Here are some of our favorite responses.

Shrimant Saxena: I have a 3570k and SLI 680s so won't be upgrading anytime soon. I haven't even overclocked anything yet.
Jason Rasmussen: Waiting for 8 cores, baby. Want to double my cores every upgrade cycle.
Luis Chinaski: Waiting for the AMD FX lineup.
Jojo Haraldsson: Will wait for Skylake, for one reason only: DDR4.
Alex J. Rollinson: Has your 2014 Dream Machine taught you nothing? I'm planning a double computer that utilizes both Haswell-E AND Skylake. Can someone lend me $30,000?
Willie Crawford: Have fun paying those DDR4 prices for those super benchmark numbers!
Tyler Perillo: I think I'll wait for the next gen with a more absurd name. CloudOcean?
Brad James: Still rocking a Sandy 2600k @ 4.2 on liquid. I will be waiting for Skylake at least.
Antonio Gurgel: Just last week I upgraded from Conroe to Haswell. Forget Skylake; wake me up when the 5nm chips are out.
Dean Michael Phillpotts: Yep! An excuse to get an i7 over my 2500K. Damn, I'm going to miss this chip.

How many cores are enough for your computing needs?



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INGREDIENTS

PART			PRICE
Case	NZXT Source 210 Elite		$50
PSU	Corsair CX500 500W		$50
Mobo	Gigabyte GA-H97M-HD3	NEW	$85
CPU	Intel Core i3-4150	NEW	$117
GPU	Sapphire Radeon R9 280 3GB 100373L	NEW	$190
RAM	2x 4GB Patriot Low Profile Red DDR3/1600 PVL38G160C9KR	NEW	$75
SSD	128GB Crucial MX100	NEW	$81
HDD	Seagate Barracuda 1TB		$60
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $808

THIS SYSTEM HAD AN AMD FX-6300 CPU in it for a long time, so we wanted to give Intel a shot. The Core i3-4150 is a dual-core chip with Hyper-Threading, for a total of four threads. Not as many as the 6300's six threads, but it turns out that the i3 is still a very feisty chip for gaming. The H97 motherboard is also compatible with the upcoming Broadwell CPUs, so it has a better upgrade path. Since we're using Intel's bundled CPU cooler this time, the savings there allow us to upgrade the GPU from a Radeon R7 270 to a Radeon R9 280. We've also reduced the capacity of the SSD by half, but we think it's worth the trade-off for stronger gaming performance.

MIDRANGE

INGREDIENTS

PART			PRICE
Case	Corsair Vengeance C70		$108
PSU	EVGA 220-G2-0850-XR 850w		$128
Mobo	Gigabyte GA-G1.SNIPER Z97	NEW	$161
CPU	Intel Core i5-4690K		$240
Cooler	Cooler Master Nepton 280L	NEW	$120
GPU	Sapphire TRI-X OC Radeon R9 290		$415
RAM	2x 4GB Patriot Low Profile Red DDR3/1600 PVL38G160C9KR	NEW	$75
Optical Drive	Samsung SH-224DB/BEBE		$20
SSD	Crucial MX100 256GB		$116
HDD	Seagate Barracuda 3TB ST3000DM001		$110
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $1,593

GOING FROM A LOCKED INTEL CORE I3 to an unlocked Core i5 is a big boost in performance. We previously paired it with a Gigabyte GA-Z97X-UD5H, which is a feature-packed mobo. However, the G1 Sniper Z97 has the nicest integrated audio we've seen, powered by a quad-core chip designed by Creative Labs. But the UD5H has SATA Express and M.2, so there are trade-offs. Do you need extra-fast storage devices, or do you game and listen to music a lot? Switching to a Cooler Master Nepton 280L from the Corsair H100i was easier, since the Nepton has a larger radiator and doesn't cost much more. All three CPU coolers should allow an overclock to around 4.5GHz.

TURBO

GOING FURTHER FROM AN INTEL CORE I5 CPU to a Core i7 gets us Hyper-Threading again, this time for a total of eight threads. Some games have begun using more than four, so it's good to be prepared. This system will also encode videos much faster. We've switched our power supply from the XFX P1-1050-BEFX because it was out of stock, and the EVGA 120-G2-1000-XR 1000W has a whopping 10-year warranty without being more expensive. Either way, this is the kind of juice you want when adding a second Radeon R9 290 video card. We could probably get by with a little less, but it's better to be safe than sorry. The NZXT Kraken X61 is a bit fancier than the CPU cooler in the other build; its pump adjusts its speed dynamically according to temperature, which in theory can extend its life. The Kraken also has software with some extensive monitoring features. They're scheduled to come out with mobile apps that will let you check on your PC remotely. We might upgrade this system to Haswell-E, if it doesn't break the budget.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best.

INGREDIENTS

PART		PRICE
Case	NZXT Phantom 530	$130
PSU	EVGA 120-G2-1000-XR 1000W NEW	$147
Mobo	Gigabyte GA-Z97X-UD5H	$175
CPU	Intel Core i7-4790K	$340
Cooler	NZXT Kraken X61	$140
GPU	2x Sapphire TRI-X OC Radeon R9 290	$830
RAM	4x 4GB G.SKILL Ripjaws DDR3/1600 F3-12800CL9Q-16GBRL	$150
Optical Drive	LG Blu-ray Burner WH16NS40	$70
SSD	Samsung 840 EVO 500GB MZ-7TE500BW	$250
HDD	Seagate Barracuda 3TB ST3000DM001	$100
OS	Windows 8.1 64-bit OEM	$100

Approximate Price: $2,432

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